

Myanmar aquaculture and inland fisheries



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The freshwater mission would also like to thank the Department of Fisheries and Myanmar Fisheries Federation (Mandalay and Shan State) for their logistical support to the mission without which the mission would not have been able to visit the extensive number of state and private fishery operators and gain the insights into Myanmar fisheries that they did.

Executive summary

There are repeated references to the crucial importance of fish and fish products in the nutrition and livelihoods of the Myanmar people. Whilst it is certainly recognized that fish is second only to rice in the Myanmar diet, there is little information available on the patterns of consumption, inter-regional differences, availability and types of fish consumed. In this respect Myanmar is similar to many Southeast Asian countries where emphasis is paid to rice production as a crucial element of food security, with little or no recognition of the fish component, which gives the rice-based diet much of its nutritional value outside of calories and crude protein.

At the 13th Governing Council Meeting of the Network of Aquaculture Centres in Asia-Pacific (NACA) in Langkawi, Malaysia in 2002, the representative of Myanmar made a request to NACA for support to the aquaculture and inland fisheries sectors. In response, NACA, the Australian Centre for International Agricultural Research (ACIAR) and the Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific (FAO RAP), fielded an aquaculture and inland fisheries mission to Myanmar on 2 to 12 December 2002.

The purpose of the mission was:

- To review the status of aquaculture and small-scale inland fisheries.
- To identify areas for technical assistance to Myanmar to address some priority concerns related to sustainable development of coastal and inland aquaculture and management of aquatic resources.
- To identify immediate assistance opportunities through NACA, FAO and other donor-mediated mechanisms.

After an initial period in Yangon for consultations with the Department of Fisheries, United Nations agencies and NGO's, the mission split into two teams: one team visited coastal areas; and one team visited inland areas. This executive summary provides the combined conclusions and recommendations from the inland and coastal teams.

Inland fisheries and aquaculture: conclusions and recommendations

The people of Myanmar are poor compared to most other countries. Although no comprehensive poverty statistics are available, generic poverty indicators include:

Stagnating GDP; low total daily expenditure (between 0.28-0.57 US\$ compared to the World Bank's somewhat broad-brush poverty level of US\$ 1/day); slender and volatile purchasing power; limited state managed welfare (impacting heavily on non-food producer's access to food); low calorific intake (less than half of the World Bank's basic nutritional needs of 2 250 calories/day).

However, Myanmar has impressive freshwater capture fisheries. Inland waters are made up mainly of the interlocking/mingling of riverine and estuarine systems of the Ayeyarwaddy (2 150 km long), Chindwin (844 km; a tributary of the main Ayeyarwaddy) and Sittaung Rivers (563 km) plus the large Thalwin River (2 400 km) to the east and a small section of the Mekong River basin. Together these systems extend from the eastern part of the Bay of Bengal to the Gulf of Moattama and along the eastern edge of the Andaman Sea. Myanmar potentially has an inland fishery greatly exceeding that of any single national part of the Mekong River basin, and quite feasibly rivals that of the lower Mekong Basin in its entirety.

These resources support, in many ways, the livelihoods of the people of Myanmar. Examples include: leasable fisheries (including sub-leasing), small-scale capture fisheries (artisanal fish trap operations, larger trapping gears, trapping of fish resources in paddy fields), small-scale fish marketing (women who catch and sell fish, fish marketing systems such as that at Thaug Tha Man in Mandalay Division, dried fish sellers), small-scale aquaculture (family ponds, hatchery and additional services, nursing), licensed fish ponds, and aquaculture support services (such as feed production).

The following summarizes major recommendations arising from the inland fisheries and aquaculture team visits.

Information, statistics and appropriate valuation of fisheries resources

1. The role of fish and aquatic foods needs to be adequately evaluated, with special attention paid to the distributional aspects and penetration of both fresh and preserved fish into remote areas.
2. The leasable fisheries and open fisheries resource areas vary every year according to the extent of flooding. More effective mapping of these resources would facilitate the Department of Fisheries, Myanmar in estimating the likely production of these fisheries as well as allow better demarcation of individual leases.
3. It is crucial that fisheries related questions are appropriately incorporated into the household survey proposed by UNDP. Care must be taken to identify issues relating to access to fish, and the extent households undertake gathering, collection and purchase. Asking families if they fish is not sufficient and will almost certainly give a misleading impression of the importance of fish in the livelihoods and diets of the Myanmar people.
4. The Department of Livestock and Fisheries could incorporate some simple questions about rice-field fisheries into a proposed agriculture census (because the department's statistics do not cover rice-fields).

Aquaculture and aquatic resources in rural development

5. It is highly recommended that future poverty focused food security development involving small-scale pond aquaculture be considered also in Myanmar.
6. It is recommended that poverty alleviation objectives of the Department of Fisheries focus on those most vulnerable to hunger, who are likely to be the landless, the urban poor and small-scale producers, each with limited capacity to secure entitlement to food.
7. It is recommended that the capacity of line agency staff to investigate and understand the livelihoods of poor people who manage aquatic resources, and their capacity to use this knowledge in the development of policies, legislation and support services be strengthened. It should be recognized that this is a considerable undertaking.
8. There appears to be considerable scope for further enhancement of leasable and floodplain fisheries through stocking of advanced large sized fingerlings, using appropriate stocking rates and possibly strategic feeding in some of the smaller leases.
9. The mission is of the view that Myanmar should take steps to reintroduce reservoir fisheries, initially on a small scale (and in conjunction with the irrigation authorities) and over time, supported by research, evolve suitable strategies to optimize yields, including the cost-effectiveness of any proposed stocking programme that is to be included, and sustain it in the long term.
10. Rice fish culture can only be piloted in a practical situation where the impacts can be evaluated, ideally with the participation of farmers, this ensures that results are grounded in the realities of their farming systems (i.e. participatory/farmer based research).
11. It is recommended that more nursing of stock for enhancement be undertaken by Department of Fisheries stations to increase the effectiveness of enhancement programmes.

Institutions, communications and networking

12. It is strongly recommended that Myanmar Department of Fisheries increase its formal and informal networking with other line agencies and organizations within Myanmar and also with similar national networks in other countries. It is recommended that Myanmar contact the NACA secretariat to investigate playing a role in the Support to Regional Aquatic Resource Management (STREAM) initiative in this regard.
13. It is recommended that the communication remit of Myanmar Fisheries Federation be expanded and that links be made with other organizations in other parts of the world so that lessons learnt elsewhere may be shared with fishers and farmers in Myanmar and

Myanmar can also share its insights and learning with the rest of the world.

Research priorities

The Mission recognized the following areas as research priorities, and recommends that the Department of Fisheries, Myanmar liaise with the Australian Centre for International Agricultural Research (ACIAR) and other donor agencies to develop suitable research projects.

14. The mission is of the view that moderate research inputs into typical leasable fisheries in a selected region, e.g. Upper Myanmar, will enable increased fish production in such fisheries, and could have positive influences on improving the lives of the communities involved in such fisheries and on the fish supplies in rural areas. Research on leasable fisheries in non-perennial waters might develop suitable stocking strategies, including species combinations, cost-effectiveness of stocking, and the socio-economics of such fisheries.
15. Inle Lake in Shan State is an important natural resource. In the recent years the traditional, small-scale “floating gardens” have been expanded significantly through the intervention of commercial growers. The lake supports the livelihood of at least 800 fisher families and is the main source of animal protein for the inhabitants of Nyaung Shwe Township and many of the surrounding townships that purchase the fresh and dried fish produced. The increasing intensity of local agricultural activities is bound to increase the nutrient and pesticide load in the lake. The consequences of such increases are difficult to predict at this stage. It is proposed that a study be conducted on the livelihoods of fishers and farmers around the lake and the changing physio-chemical character of the resource (e.g. water quality and the fishery of Inle Lake). It is expected that such a study will help in bringing about suitable management measures for the fishery, in the light of increasing and possible eutrophication of the water body.

In the event that the Department of Fisheries, Myanmar adopts the recommendation to reintroduce reservoir fisheries, it will be imperative that a new management strategy be developed for the fisheries. In order to do so it is suggested that a research programme be undertaken in conjunction with potential fishers/fishing communities/Department of Fisheries to develop a co-management strategy(s) to ensure the long term sustainability of the fishery resources.

Coastal aquaculture: conclusions and recommendations

Coastal aquaculture in Myanmar is mainly limited to shrimp farming, with smaller quantities of mud crab and groupers farmed. The sector already contributes significant export earnings, and shows potential for future development and diversification. Extensive brackishwaters, tidal estuaries and clean marine environments exist along a long coastline of nearly 3 000 km, with significant scope for coastal

aquaculture development. Most coastal aquaculture in Myanmar is practiced with traditional methods, but intensification of shrimp farming in particular is gathering pace. Because of low urbanization and industrialization in coastal areas, water pollution caused by chemical and industrial waste is negligible providing opportunities for production of high quality products. However, degradation of the resource base and habitats, such as coastal mangroves and coral reefs, is a concern. Government policy is supportive to expansion of coastal aquaculture, but careful attention is required to ensure the sustainability of coastal aquaculture, to maximize creation of opportunities for employment, income generation and improve livelihoods of the many people living in Myanmar's coastal areas.

The following summarizes major conclusions and recommendations arising from the coastal aquaculture team visits to Yangon, Rakhine and Thanintharyi regions.

Coastal communities

The general picture that emerges from the mission, and review of secondary information, is of a coastal population that includes significant numbers of poor and vulnerable people with a high proportion dependant on fisheries activities and aquatic products for income and nutritional security. Coastal aquaculture development is presently quite limited, but already the livelihoods of perhaps several thousand people are directly and indirectly linked to the sector.

There appear to be significant barriers to entry of poor people directly into coastal aquaculture. These barriers seem to include land access, skill acquisition, access to credit and support services, scarce availability of small land holdings, lack of micro-credit systems and security of land tenures.

1. The mission was unable to evaluate to what extent poorer members of the coastal community have already benefited from coastal aquaculture. Opportunities may be substantial to support local development through sustainable aquaculture initiatives. Information is required (e.g. through livelihood analysis in Rakhine and Thanintharyi regions) to better understand livelihoods and gauge opportunities for participation in aquaculture. Such information could be obtained by the upcoming UNDP census, or perhaps through special local (e.g. township) level assessments.
2. Investment in coastal aquaculture so far is focused on export commodities; and it appears to be mainly wealthier individuals/companies who are directly involved, with shrimp as the main item, and smaller quantities of crab and grouper. Investment by larger companies/individuals has proved important in developing technology and infrastructure for aquaculture, for example, private sector investment support to shrimp hatcheries, and employment, such as several hundred people involved in Myeik (women in soft-shell crab farm) and input supplies (mud crab, trash fish, and grouper fry supply to cage farms in the Thanintharyi division).
3. The opportunities for participation of local smallholders in coastal aquaculture should be further explored, and government, donor and private sector investment could then be focused on support to poor people where appropriate. There are major questions of technology, extension support, capital access and security that remain unanswered on the potential for small-scale poverty-focused mariculture. If non-technical constraints can be better understood and addressed, technology for several species might offer opportunities to support small-scale aquaculture in coastal areas, which will contribute to foreign exchange earnings and poverty alleviation in coastal areas.
4. There are questions about the resource sustainability of aquaculture systems based on capture of wild stocks. Mud crabs, grouper and potentially lobster culture, are based on capture of wild stocks. The sustainable development of such systems depends on sustainable supply of inputs (feed and seed). Value-added culture can provide positive economic benefits to fishers and the country, as they value add to existing resources and provide foreign exchange. However, sustainability is a long-term issue and it is already apparent that for groupers this is already an emerging constraint.
5. Research should be conducted on capture fishery based aquaculture systems to determine the sustainability of present practices, and used to prepare advice on sustainable management. Mud crab farming and fattening practices show considerable potential for smallholder involvement and should be given priority in such research, because of the high volume captured and traded.
6. Shrimp farming in mangrove environments, classified as 'secondary' mangrove habitats, raises questions of sustainability due to acid sulphate soils, and downstream environmental and social effects due to replacement of mangroves with shrimp ponds, particularly low productivity extensive systems requiring large areas. The role of secondary mangrove systems should be assessed and effective mangrove management plans put in place. Mangroves should be evaluated for their contribution to fisheries, acid-sulphate soil problems, economic values, and retention for mixed silviculture/shrimp farming to diversify income risk among farmers. Knowledge of sediment dynamics in these coastal regions is also required to identify the role of coastal mangroves in sediment entrapment deposition and erosion.
7. The productivity of existing shrimp farming systems developed in mangrove areas is extremely low, in some cases probably less than the fishery values of original mangrove resource (commonly 100-150 kg/ha of fisheries products from other regional countries, but values need to be verified for Myanmar). Upgrading and rehabilitation of low productivity coastal ponds and degraded mangrove areas should therefore be given

Environmental issues, resource sustainability

attention. This may involve introduction of improved aquaculture systems, such as mud crab culture, and restoration of mangroves where suitable. Opportunities exist for sharing experience with previous ACIAR and NACA projects on mangrove-aquaculture systems in Viet Nam and acid-sulphate soil mapping in Indonesia.

8. The Department of Fisheries is making progress in environmental management of more intensive shrimp farms, and is encouraging the private sector through zoning and water treatment protocols. These initiatives are welcome and should be continued and improved for effective environmental management of the sector, and for ensuring sustainability of existing private sector investments. A comprehensive environmental management plan should be agreed with private sector investors in the shrimp industry in Myanmar as a voluntary Code of Conduct for future investment and development of the industry.
9. There is a need to explore and introduce effective coastal planning to support balanced development in coastal areas between aquaculture, coastal fisheries, and other coastal resource uses. The land use policy in coastal areas is directed towards agriculture development, and there appears to be lack of flexibility in using agriculture land for aquaculture. This may be focusing shrimp farm development towards less suitable mangrove areas, whereas more suitable aquaculture sites may be available on sub-optimal agriculture land.
10. Coastal planning processes and zoning should be reviewed as a basis for moving towards more integrated coastal planning processes that would allow for balanced use of resources for aquaculture in harmony with other uses. As integrated coastal planning and management appears to be a new concept in Myanmar, one or two pilot areas might be used for testing and development of a suitable approach, for subsequent wider adoption. Zoning principles should also be applied to separate major shrimp farming and hatchery zones away from each other, as part of a health management strategy for the shrimp industry.
11. Coral reefs are probably important for sustaining coastal fisheries, particularly in the southern part of Myanmar. Further information on the status of coral reef resources, the people dependant on them, fishing practices and conservation status, should be obtained. This would form the basis for establishing suitable management measures for this important resource. The Department of Fisheries has institutional responsibility for one marine protected area in a coral reef area, but has limited capacity and awareness of coral and marine protected area management. It is recommended to build awareness and capacity within the Department of Fisheries for marine protected area management. The Department of Fisheries is also encouraged to explore linkages with the Global Coral Reef Monitoring Network (GCRMN).

Aquaculture technology

12. Most shrimp farms practice traditional methods, but the Department of Fisheries is trying to encourage improvement of extensive systems, and intensification of shrimp farming in particular is gathering pace with several recent investments in more intensive shrimp farms. The technology and management practices can be further upgraded through capacity building and awareness campaigns based on experiences in other Southeast Asian countries, particularly on issues that influence the sustainability of the sector (e.g. shrimp disease and environmental issues).
13. There are several promising species for diversification of coastal aquaculture in Myanmar, and considerable opportunities to learn from other countries in the region. Therefore, technical cooperation with other countries in coastal aquaculture technology and management should continue to be promoted. A programme of technical exchanges should be established to effectively draw on experiences of other countries for development of sustainable coastal aquaculture in Myanmar. Such networking should include the Department of Fisheries, the private sector, educational institutes and NGOs (such as the Myanmar Fisheries Federation (MFF) and others active in community development).

Institutional support and capacity building

The Department of Fisheries appears to be mainly focused on licensing and quality assurance through a laboratory in Yangon. A coastal station is planned near Myeik to support mariculture development in an area with significant potential.

14. In general, the mission felt the need for capacity building in extension and delivery of services to the private sector and coastal poor engaged in aquaculture/fishers.
15. Capacity building among Department of Fisheries staff, and particularly the younger staff, should be given a high priority. Education and training should be addressed through both short and long-term approaches. A structured approach and plan involving the Department of Fisheries, universities and NGO's should be prepared for long-term capacity building in the sector.
16. Donor assistance might be provided in designing and developing course materials, training of trainers and teaching, both within the Department of Fisheries and in NGOs (e.g. MFF) for better informed management of coastal aquaculture development in Myanmar. Promoting linkages to other countries in the region is essential for effective exchange of experiences and capacity building.
17. The Department of Fisheries recognizes the potential for future development of mariculture in the southern part of Myanmar. The main initiative for mariculture

development in this area within the Department of Fisheries is the plan to establish a marine aquaculture station at Kyun Su Township in Thanintharyi division, starting in 2003. The Department of Fisheries plans to start work with seabass culture, but eventually will extend to include groupers. External assistance should be considered for training of staff, and design of the facility.

Aquatic animal disease control and health management

Shrimp disease problems have recently emerged and are already causing severe economic impacts on shrimp farms, in Myanmar, including semi-intensive and extensive farms. The effects on wild populations are unknown, but it appears that shrimp broodstock are already infected with white spot syndrome virus (WSSV) to varying degrees. There is evidence that WSSV was introduced to the country through introduction of shrimp post-larvae. The current situation, if not brought under control through urgent and coordinated action, represents a serious threat to the sustainability of shrimp farm investments, Myanmar's ability to attract foreign investment, and future trade status.

18. Policy should be clearly developed on the introduction of aquatic species to Myanmar. Practical implementation of the Asia Regional Technical Guidelines on Health Management and Responsible Movement of Live Aquatic Animals is essential.
19. The current ban on further imports of live aquatic animals should be continued, including *Penaeus monodon* and *Penaeus vannamei*, since there are no risk assessment measures in place for imports, and no facility for quarantine and extensive testing of the quality of the imported animals. Introduction of suitable risk assessment procedures, in cooperation with the private sector, is strongly recommended. As Myanmar will likely continue to receive requests from the private sector for imports of *P. vannamei*, further advice should become available from an assessment being planned by FAO/NACA in 2003.
20. White spot syndrome virus (WSSV) is proving to be the major current problem in shrimp culture, and the mission has identified major risks and actions that can be taken, based on experiences in other countries:
 - a) Establish disease-testing facilities in major broodstock sourcing areas, with priority on Thandwe, to reduce the chance of postlarval (PL) contamination;
 - b) Introduce a PCR testing centre in the southern area (for example in Myeik);
 - c) Support PCR testing laboratories by development of standard protocols, training and laboratory procedures. Other countries within the region can provide assistance in such training and protocol development;

- d) Urgent extension programmes should be undertaken. The government lacks experienced extension staff to support local farmers, and a concerted effort and collaboration between government and the private sector should be initiated as a matter of urgency to ensure that farm staff are properly trained and equipped with the know-how to identify and manage disease problems;
- e) A health management "Code of Practice" should be agreed between government and private sector, including an agreed programme of broodstock testing, chemical and drug use and an agreement on imports, that should be a condition of investment in the shrimp farming business in Myanmar; and
- f) Existing experiences from NACA, FAO and ACIAR support in the Asian region should be engaged to support development of a responsible shrimp sector.

21. The use of chemicals in shrimp aquaculture remains a serious concern. The team recommends development of regulations, with the private sector, on chemical and drug use, including a list of banned chemicals, instructions on safe storage/use, ingredients and withdrawal periods clearly written in the Myanmar language.

Business investment in coastal aquaculture

22. There are several large investments on-going or planned for coastal aquaculture in Myanmar. The mission was concerned whether the question of (environmental, economic, social) sustainability had been fully addressed, and what incentives exist for long-term perspectives on investment. Problems have already emerged because of introduction of disease by the private sector, which has jeopardized shrimp farm development in Myanmar. The private sector should be encouraged to positively support the development of the sector, such as through longer-term capacity building, development of Codes of Practice (e.g. regarding local employment, movement of live aquatic animals, etc.). The mission suggests a Code of Practice be developed that would be a condition of further investment in the sector.

Market trends and implications

23. The current markets for coastal aquaculture products are almost solely export oriented. Products are exported to a wide range of countries, as frozen product (shrimp, soft-shelled crabs) or in live form (mud crabs, groupers and lobsters). There are a number of market trends that have implications for coastal aquaculture, particularly shrimp (chemicals, trace-ability, certification) and live marine fish (standards are currently being developed for import of live fish to Hong Kong by the Asia-Pacific Economic Cooperation (APEC)). These regional and global trends will influence the future development of aquaculture in Myanmar. The team considers that Myanmar's coastal environment offers opportunities for a "clean and green" image for aquaculture products.

24. There has been some commendable work on quality assurance in Myanmar, and there is a need to continue to develop quality assurance/clean quality products through working closely with the private sector. Therefore, the emphasis should be towards responsible development of the sector. This may be accomplished by the development and adoption of Codes of Practice with the private sector that would provide a basis for a set of informal “rules” that might guide investment and management of the export-oriented sector. Myanmar is also encouraged to engage in regional and international discussions on such issues and promote international investment in aquaculture that adheres to such codes and emerging certification principles.

Coastal fisheries resources

25. The mission noted the need to generate more updated information on maximum sustainable yields of marine fish stocks, as a basis for sustainable management. Illegal, unregulated and unreported (IUU) fishing, including possible use of destructive fishing practices in coral areas should be further investigated and actions taken to address problem areas. The mission did not investigate this issue in detail, but felt it was worth noting that there is a need to generate a better understanding of marine fish stocks and catches to provide a sound basis for sustainable management. FAO, UNDP, Southeast Asian Fisheries Development Center (SEAFDEC) and other supporting agencies may be approached to support such investigations.

Entry points for support in coastal aquaculture

The mission has identified several initial entry points for collaborative support with particular reference to the programme areas of NACA, FAO, UNDP and ACIAR programmes. The priority areas include:

- Better understanding of livelihoods of people living in coastal areas, and development of smaller-scale aquaculture farming systems that directly support the livelihoods of poor people. Initial information on coastal livelihoods might come through incorporation of relevant fisheries questions into upcoming censuses and also cooperation with the Asian regional STREAM Initiative.
- Research on the resource sustainability of coastal aquaculture systems, perhaps initially emphasizing mud crabs that represent a significant opportunity for small-scale aquaculture development.
- Development of strategies for environmental sound planning for coastal aquaculture development and integrated coastal area management.
- Research to understand the values of coastal mangrove forests and improving integrated aquaculture-mangrove farming systems.
- Support to the development of the mariculture station and programme in southern Myanmar, an area with significant coral reefs and fishery importance.
- Implementation of more effective shrimp health management strategies as a matter of some urgency.
- Support to development of a set of better management practices (BMPs) or a Code of Practice that can provide the basis for an agreed set of rules for shrimp farm development by the private sector, and ultimately support sustainable development of the shrimp sector and market access.
- Institutional development through education and training as a long-term initiative to build capacity for responsible management of the coastal aquaculture sector.
- Continued technical exchanges in mariculture development and better management practices in shrimp culture with other countries in Asia.

Background to the mission

Following a request from the representative of Myanmar made during the 13th NACA Governing Council meeting in 2002, a mission was organized to Myanmar from 2 to 12 December 2002. The mission comprised expertise from NACA, FAO and Australia (AIMS and ACIAR).

The purpose of the mission was:

- To review status of aquaculture and small-scale inland fisheries;
- To identify areas for technical assistance to Myanmar to address some priority concerns related to sustainable development of coastal and inland aquaculture and management of aquatic resources; and
- To identify immediate assistance opportunities through the NACA framework and other donor-mediated mechanisms.

After an initial period in Yangon, the mission split into two teams: one team visited coastal areas and the other team visited the inland areas. The results of these two missions are presented as separate reports:

- Mission report on inland fisheries and aquaculture
- Mission report on coastal aquaculture

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Myanmar fisheries sector

Myanmar has a coastline of nearly 3 000 km, a continental shelf of 228 000 km² and an Exclusive Economic Zone of



486 000 km². Inland freshwater bodies cover 8.1 million ha of which 1.3 million ha are permanent; the remainder are seasonally inundated floodplains.

Fisheries are the fourth most important source of export earnings, valued at US\$ 218 million in 2001 (DoF, 2002). Marine capture fisheries is reported to produce 932 090 tonnes, freshwater capture fisheries 235 530 tonnes (DoF estimates of leasable, open and floodplain) and aquaculture 115 870 tonnes.

It is uncertain whether marine or freshwater capture fisheries still have expansion potential, although recent reviews have suggested that the inland fisheries potential of Myanmar is far greater than the 235 000 tonnes reported (possibly as much as 600 000-900 000 tonnes based on revised estimates from the Mekong system). This is partly due to the non-inclusion of fisheries production for household consumption which is predominantly derived from rice fields and their associated streams and channels.

Official Statistics are typically focused on fish production and in particular, revenue generating exports. This tends to exclude or undervalue the wide range of other aquatic products that are also routinely consumed in rural households. The leasable inland fisheries may also be benefiting from the effects of interventions aimed at enhancing production, which also gives encouraging potential for increased contribution for the inland fisheries sector in supporting the livelihoods and food security of the people of Myanmar.

Myanmar – mission report on inland aquaculture and fisheries



Myanmar – aquaculture and inland fisheries

Inland fisheries and aquaculture resources

Myanmar has impressive freshwater capture fisheries. The inland waters are made up mainly of the interlocking/mingling of riverine and estuarine systems of the Ayeyarwaddy (Irrawaddy, 2 150 km long), Chindwin (844 km; a tributary of the main Ayeyarwaddy) and Sittaung (563 km) rivers, plus the large Thalwin River (2 400 km) to the east. The first three have adjacent deltas and are arguably part of a larger joint system. Together these systems extend from the eastern part of the Bay of Bengal to the Gulf of Moattama and along the eastern edge of the Andaman Sea. The Ayeyarwaddy River alone has a mean discharge of 13 500 m³/second from its catchment of 424 000 km² (Welcomme, 1985), notably, practically all within Myanmar.

Aquatic resource area of the river systems within Myanmar encompasses a total of 8.2 million ha (FAO, 1996) of permanent and seasonal water bodies and there were 29 000 ha of freshwater fishponds and a further 40 716 ha of shrimp ponds in 2001, and 115 687 ha of reservoirs (see Table 1). The Department of Fisheries (DoF) in Yangon estimates a figure of six million ha of floodplains, which likely excludes river area and floodplain lakes. This approaches that of the entire Mekong Basin (>seven million ha, MRC, 2001).

The country also includes a small section of the Mekong River basin but is not a member of the Mekong River Commission. The Mekong River which has only a slightly higher discharge (15 000 m³/second) but a greater length (4 880 km) and larger catchment (795 000 km²) (MRC, 2001). With a total population of about 50 million, Myanmar potentially has an inland fishery greatly exceeding that of any single national part of the Mekong River basin, and quite feasibly rivals that of the lower Mekong Basin in its entirety. There are also great similarities in the fisheries of the Ayeyarwaddy and Mekong and Myanmar presents a fascinating opportunity to compare statistics and experiences between these regions, with potential for extension to elsewhere such as South America.

For management (licensing/regulation) purposes Myanmar divides its inland capture fisheries into two main categories:

1. “Inn” leasable fisheries. These are almost exclusively key fishing grounds on floodplains which are primarily fished through the erection of barrage fences around the lease area with fish collected in various collection pens or traps. The peak season involves capturing fishes migrating off the floodplain at the beginning of river draw-down. Lease holders enjoy exclusive rights to fish the lease area including preventing access by others and a certain degree of environmental management and control. This is referred to locally as the “Inn” fishery. For present purposes it is the same as the floodplain (and Great Lake) barrage fishing components of the “Lot” system in Cambodia. There are currently 3 722 leasable fisheries in Myanmar of which 3 490 are
2. Open fisheries. These are fisheries in all other areas including all types of fishing operation. The right to fish in these areas is licensed out by DoF. All fishing gears require a license. For most this is a set fee. Some of the larger gears, particularly “bagnets” set in rivers (comparable to those used in the lower Mekong), are allocated by a tender system (“tender fisheries”). Fees are variable between regions according to production and capacity. License fees for smaller-gears are low. Although the policy is for complete coverage of licenses for all gears (a monumental task in such a fishery) it was intimated that licenses tend to be neglected for smaller gears and the system concentrates on those people perceived as fishing for “profit”.



Livelihoods from small-scale fish marketing

These women derive a livelihood from two days of fishing and two days of selling every five days. Inle women who catch and sell fish at several of the markets held on the traditional 5-day rotating basis. (See discussion of Inle fish catchers and seller)

still exploitable. Of these, 1 738 (52.3 percent) are located in Ayeyarwaddy Division (the lower floodplains and delta of the river). Leases have been auctioned every year but DoF is extending the lease period to up to 9 years to promote improved long-term management. There are no government owned leases. A register of leases is kept and details of lease arrangements are held on Land Revenue Forms.

Officially, it is a requirement for all licenses that holders report their catches, although in practice, this is only likely for the larger leasable fisheries and larger fixed gear fisheries. This is another source of underestimation of the actual status of the production from inland fisheries. The entire fishery is closed during June, July and August (to allow spawning and recruitment). In practice this is probably enforced only for the Inn fishery, tender fisheries and larger gears. The small-scale fishery occurs year-round and is considered technically “illegal” during these months.

The role of inland fisheries and aquaculture in people’s livelihoods in Myanmar

There are repeated references to the crucial importance of fish and fish products in the nutrition of the Myanmar people. Whilst it is certainly recognized the fish is second only to rice in the diet of Myanmar, there is little information available on the patterns of consumption, inter-regional differences, availability and types of fish consumed. In this respect Myanmar is similar to many of Asian countries where emphasis is paid to rice production as a crucial element of food security, with little or no recognition the fish component which gives the rice-based diet much of its nutritional value – in addition to calories and crude protein.

The size and scale of activities and opportunities within the inland fisheries and aquaculture sector varies from very small-scale to large-scale commercial operations. The livelihoods that were identified during the visit are:

- Leasable fisheries (including sub-leasing);
- Small-scale capture fisheries (artisanal fish trap operations, larger trapping gears, trapping of fish resources in paddy fields);
- Small-scale fish marketing (women who catch and sell fish, the fish marketing system at Thaug Tha Man in Mandalay Division [U Min Wai, personal communication], dried fish sellers);
- Small-scale aquaculture (family ponds, hatchery and additional services, nursing);
- Licensed fish pond; and
- Aquaculture support services (feed production; naturally occurring fodder supply).

This section is drawn from discussions and information collected during visits to Government Fisheries Stations and Fisheries Offices, Leasable Fisheries and Licensed Fisheries and large and small-scale Aquaculture Operations in Yangon Division, Mandalay Division and Shan State (see Annex 1, mission itinerary for details of places visited and Annex 3, persons met).

Participation in capture fisheries

Very few of the countries record participation in the capture fisheries sector to any significant degree in their statistics. Most do not record it at all. Some only report licensed fishers. None record participation in fishery-related activities often include those involved in processing, marketing, transportation and gear construction etc. Myanmar has a more extensive licensing system than other countries in the region and reports 1 398 410 fishers operating in inland waters in 2000-2001. This is higher than for the marine sector (1 278 000 fishers) and is approximately 3.5 times the number of fish farmers. Even so, the figure for inland waters is based on licensee records and in practice many small gears are not included and rice-field and reservoir fishing is excluded (the latter as a result of the ban on reservoir fisheries since 1998).

The inland fisheries of Myanmar almost certainly involve more people than reported since many families will engage in occasional, seasonal or rice paddy type fisheries, which is unlicensed and largely unreported. Thus this sector is probably impacting a far greater percentage of the population than currently recognized.

The number of people employed in the aquaculture sector are cited as 612 000 of which 175 000 are employed full time (Kyaw, 1998). This type of categorization does not particularly reflect the relative livelihood importance of the activity and the contribution to household income security and vulnerability reduction.

Gender aspects

Gender is used to describe all the socially given attributes, roles, activities and responsibilities connected to being female or male in a given society. It is one marker among others such as age, race, ethnicity, class, disability, connections, education and sexual orientation etc., that determines status.

Table 1: Freshwater resources in Myanmar

Freshwater fisheries resources	Area (ha)	Number	Likely productivity (kg/ha)	Theoretical annual production (tonnes)
Seasonal floodplains	8 100 000	no data available	no data available	no data available
Permanent water bodies	1 300 000	no data available	no data available	no data available
Leasable fisheries	no data available	3 483 (3 722)	no data available	no data available
Reservoirs	115 687	103	150	17 350
Freshwater aquaculture ponds (fish)	29 000	no data available	750	21 750



Women operate hatcheries as well as undertake routine management of fish ponds

“I inherited three acres of land from my parents in 1983 and created borrow pits elevating flood land on which to build a house. As the borrow pits flooded I grew fish. Then I came to realise that nursing fry to fingerlings was better business. Most market demand is for Rohu and Common carp.” Over the last 20 years demand has increased year on year. It is not possible to satisfy the demand, small size is most popular” – small fish nursing and supply business east of Mandalay.

The involvement of both men and women in fisheries and aquaculture is evident in all of the locations visited by the mission. Fishing and harvesting from aquaculture is practised by male household members but women also often play an important role. Some small-scale fishers around Inle Lake are women and the marketing of fish is almost exclusively the domain of women.

In several of the small fish pond culture and hatchery operations visited by the mission the women of the household either managed the operation or were engaged in routine management operations, such as feed preparation and/or feeding.

It is possible that in Myanmar, in common with other places in Southeast Asia, much of the foraging of paddy field aquatic resources (such as fish, frogs, etc.) is an activity of women (and children). For this reason surveys that focus on male head of households often fail to completely capture fishing activities of a household.

Securing food

In common with many of its neighbours, rice and fish are key staples in Myanmar. Fish, commonly small fresh fish, dried fish, fish paste and fermented fish products from inland fisheries and aquaculture was observed to exceed other

animal protein sources such as meat and eggs in local markets by a factor of 10:1. All those interviewed whose livelihoods fall within the fresh water fisheries sector reported demand in excess of supply. The price difference between red meats and fish (common varieties) are in the region of 4:1.

However, the key food production focus of the government is currently rice, and significantly the Department of Agriculture has representation down to village level. The conversion of rice land to other uses is carefully controlled. Low yielding land (e.g. 5-6 baskets/acre) however may be allocated by the Land Distribution Committee (with representatives from Department of Fisheries, Department of Forestry, Department of Agriculture, Department of Rural Development and District Government) to investors for conversion to fish ponds. An example of this is found to the north of Inle Lake in Shan State, where water management is purported to have reduced the quality of former paddy land which now floods regularly. Two thousand acres of this land is now being licensed for fish production by the Fisheries Department. A number of aquaculture entrants (who have converted their paddies to ponds) have suffered ‘livelihood shocks’ (see further for detail) such as fish loss due to flooding, four years out of the last four and had to sell up. This land is retailing for around K500 000/acre and therefore represents an opportunity mainly for medium-scale or large-scale entrepreneurs.

The development of small-scale fish ponds (less than 25 x 25 feet) is not licensed by the Department of Fisheries and therefore land converted to fish ponds below 60 m² is not controlled or recorded. However, such small-scale ponds, managed initially with minimal investment have proven highly successful contributions to the livelihoods of poor farming families in neighbouring countries, especially where large fingerlings can be stocked or nursed in “hapas” before release. It is highly recommended that future poverty focused food security development involving small-scale pond aquaculture be considered also in Myanmar.

Fish consumption

Based on DoF estimates for national fish production (1 283 489 tonnes) and subtracting exports (144 624 tonnes) gives the total available fish for consumption in Myanmar at approximately 1 138 865 tonnes, suggesting a per capita consumption of 22.7 kg/caput/yr. However, the hidden production from unreported fishing and also the likely under-reporting of leasable and licensed fisheries catch means that the current national estimate should be far higher. Using estimates based on the inland fisheries areas (6 million ha of floodplain, 1.3 million ha of permanent water) of Myanmar the national per capita figure could range between 26-34 kg/capita/yr. These are only approximations and need to be verified by a household consumption study, since there will be strong differences in access to fisheries resources and distributional issues between lowland and highlands (see Table 2 for a detailed list of species present in fresh fish markets). It is interesting to note that even upland dwelling peoples, such as those in Shan State, whose cultural tendency is towards vegetarianism, will still consume small fish. For these people, access to dried as well as fresh fish is important

Table 2: Captured and culture fish species observed in markets in Mandalay and Shan State

Common Name	Scientific name
Freshwater species	
Featherback	<i>Ompok/Notopterus</i>
Snakeskin gourami	<i>Trichogaster</i>
Snakehead	<i>Channa spp.</i>
Spiny eel	<i>Mastacembelus</i>
Catfish	<i>Clarias spp.</i>
Glass fish	<i>Amblypharyngodon</i>
Rasbora etc.	<i>Rasbora spp., Danio</i>
Gobies (sand)	<i>Glossobobius spp.</i>
Freshwater eel	<i>Anguilla spp.</i>
Marine species	
Hilsa	<i>Tenualosa ilisha</i>

and might be assumed to be an essential component to their vegetarian habits.

Other indicators can show the relative importance of fish consumption. Official figures indicate per capita consumption of fish was three times higher than that of meat in 2000 (DoF, 2002).

Fish is a rich source of lysine (which complements lysine deficient rice protein) as well as all the other essential amino acids, vitamin A, essential fatty acids and calcium all of which are difficult to secure in non-fish products including many meats. The focus of investigations of the Myanmar

Table 3: Number of types/species of preserved fish in Nyaung Shwe market, Shan State

Freshwater species	Number of types on sale
Fermented fish	4
Dried fish (Snakehead, <i>Puntius</i> , Rotee, <i>Rasbora</i> , etc.)	12
Fish paste	1
Salted fish	2
Marine species	
Fermented fish	0
Dried fish	5
Fish paste	0
Salted fish	1
Shrimp paste (gnapi)	1

diet should therefore include these aspects of nutritional quality, not merely the quantity.

Preserved fish plays an evident role in the Myanmar diet although the small quantities consumed make this an often hidden contribution to the overall fish consumption, since these products can be consumed at almost every meal, they can contribute a significant proportion of the diet. In one market in Shan State alone, there were 28 different types of preserved fish (freshwater and marine, see Table 3).

Identifying the poor

Part of the terms of reference for the mission was to identify key constraints to future development of aquaculture and aquatic resource management, including its role in poverty alleviation and to recommend practical strategies to address these constraints. This first involves identifying the poor. Those studying poverty in Myanmar have reported difficulty in finding data and measuring trends, and report no systematic poverty study of Myanmar. There appear to be few indices of poverty or income distribution data available, though expenditure and percentage expenditure on food, purchasing power, calorific intake and GDP per capita is reported in the government Statistical Year Book. According to a study by Satio and Kiong in 1999 drawing on the Statistical Year Book, GDP per capita rose from around K700 after World War I to K1 600 in the late 1990's. The slow rise in GDP was punctuated by falls and periods of stagnation.

A nationwide census of expenditure was carried out in 1997 (Statistical Year Book, 1998). Expenditure on food and beverages amongst States/Divisions ranged between



“Fish supply is much diminished from previous times” (Shan Community Development Workers) in Nyaung Shwe.

65-75 percent of total expenditure. Lower Myanmar, closer to the main goods import base, Yangon (with consequent lower transport costs for imported goods) and with a productive coastal fishery tended to have lower food costs and may account for lower percentage expenditure on food compared to Upper Myanmar. Total expenditure (at 1997 prices) ranged between US\$ 0.28-0.57 with an average of 0.44 US\$/day (compared to the World Bank's somewhat broad-brush poverty level of 1 US\$/day). On this basis, Chin state (bordering poor South Asian neighbours, Bangladesh and India, lying in the unproductive dry zone) is the poorest in Myanmar (0.28 US\$) and Thanintharyi State (bordering Thailand and the lucrative Thai market, and benefiting from productive coastal resources) the richest (0.57 US\$/day). Expenditure in Mandalay Division equates to the country average.

Much of Myanmar is a fertile, productive environment where food production is unlikely to be limiting. However, slender and volatile purchasing power and limited state managed welfare would be likely to impact heavily on non-food producer's access to food. One indicator of diminishing purchasing power is changes in price of food commodities compared to minimum wage, e.g. rice has increased in price 46 times (in Mandalay between 1960 and 1995) resulting in an 80 percent decrease in purchasing power of the minimum wage over the period (calculated from figures of Khin Maung Kyi et al., 2000).

The World Bank's generic poverty indicator "income to attain basic nutritional needs of 2 250 calories per day" is almost double the calorific intake calculated from monthly food consumption reported in the Statistical Year Book (1998), which varies from below 800 in Chin to 1 200 in Bago. Urban Yangon is reported (SYB, 1998) to be 1 000 calories.

These four indicators appear to suggest that Myanmar is poor compared to most other countries. Poverty is most likely to equate to hunger for people who purchase rather than produce food. It is recommended that poverty alleviation objectives of the Department of Fisheries focus on those most vulnerable to hunger, who are likely to be the landless, the urban poor and small-scale producers, each with limited capacity to secure entitlement to food.

An example of a more detailed local investigation into poverty is the Village Profile from 463 villages in Nyaung Shwe Township (UNDP, 1999), made available to the mission from the UNDP Human Development Initiative for "planning micro-interventions in different sectors".

UNDP findings from Nyaung Shwe Township suggest:

- Approximately 40 percent landlessness (although a proportion of these people live over water on Inle Lake and can make a livelihood with floating gardens).

- 1.89 percent of houses with grass/palm thatch roofs (which might indicate poor housing condition).
- More than 95 percent of villages within 1.6 miles of a primary school, but 64 percent of the rural population without primary education.
- Health care facilities include 2 station hospitals, 5 Rural Health Centres (RHC) and 23 sub-RHC; one health centre per 17 villages at an average distance of 2.9 miles.
- 72 percent of households which use "unsanitary open pits or no latrines".

These indicative proxy indicators of poverty used by UNDP attempt to include basic factors which contribute to wellbeing such as access to farm land (food production), type of roofing system (shelter), education level and health care facilities and sanitation (health).

Understanding peoples livelihoods

According to contemporary development thinking, such data begin to explore the physical (infrastructure), natural (land, forests, fisheries) and human assets (such as health, fitness and skills) upon which people build their livelihoods. Further assets which play a vital role include financial capital (including access to credit), and the relationships of trust which link people with each other and which can also affect their access to services and support from service providers (sometimes referred to as social capital). It is the capacity of people, drawing on these assets, within the context of their vulnerability, for example to:

- Seasonal effects (on labour opportunities, climate and commodity prices);
- 'Shocks' such as flooding, drought, fire, loss of a family member or friend (and their labour or other support), or of livestock, property or services; and
- Trends (such as over-fishing, pollution, increasing population density) which determine what they can achieve.

Such knowledge and thinking can help to us understand the role that, in this case, inland fisheries or aquaculture may play in different peoples livelihoods. This in turn can help to frame Fisheries Department Policies in support of people's livelihoods, including those people that are poor who can benefit.

It is recommended that the capacity of line agency staff to investigate and understand the livelihoods of poor people who manage aquatic resources, and their capacity to use this knowledge in the development of policies, legislation and support services be strengthened. It should be recognized that this is a considerable undertaking.



Nyaung Shwe market

Leasable fisheries

Leasable fisheries are floodplain fishing grounds which are leased to individuals (or groups) for fishery activities annually (see Table 4). In a leasable fishery, the lessee has the sole right to exploit all the fish resources, using any gear. The lessee is also expected to stock species of their choice, as the flooding occurs, but the numbers to be stocked is not defined. On the other hand, there are leasable fisheries that are dependent entirely on natural recruitment of indigenous species and in exceptional cases on exotics such as *Oreochromis niloticus*. Leasable fisheries contribute to the livelihoods of large commercial operators or institutions and depending on the management of the system can support large numbers of sub-lessees and fish sellers. (A background history of the management of leasable fisheries is presented in Annex 2).

Prior to World War II there were 4 006 ‘Inn’ Leasable fisheries but post war this had declined to 3 710. By 1999 the number of leasable fisheries had further reduced to 3 474 with some of the leasable fisheries sites being converted to agriculture. If agriculture subsequently failed, the land essentially becomes ‘open fishery’ or available for exploitation by local business interests. This has apparently been the case where the promotion of agriculture, especially deepwater rice cultivation by private sector interests has seen the transformation of substantial areas of leasable fisheries into agricultural land. The subsequent failure of the deepwater rice cultivation locations did not see a return to government managed leasable fisheries and the current status, ownership and management of these ex-fisheries was not

available to the mission, although obviously of concern to the DoF due to the impacts on fisheries resources. Total current area of the leasable fisheries is estimated at about 148 500 ha.

Auction process, duration of lease and renewal

In principle, the awarding of leases for leasable fisheries is undertaken by auction (sealed bid). The auction is overseen by an auction committee which includes representatives of DoF, the Revenue Dept, the Land Allocation Committee and the Township Committee. The lease may also involve some input/suggestion from higher authorities concerning extension or to whom the lease should be awarded.

Whilst this is the nominal process, in practice the system is similar to that referred to in the description of the history of leasable fisheries from 1948 (Annex 2 – U Maung Khin, 1948). In this case there is some discretionary power to re-award the lease to a ‘good leaseholder’ and also support from members of the auction committee obviously strengthens a case. The lessees visited had all had continuous leases for the past 8 years, although it can be expected that smaller leasable fisheries and less influential lessees might not enjoy such extended terms of leasing. It needs to be noted that the mission did not have the opportunity to meet with any previous lessee nor visit a lease that has changed “ownership”.

There is an apparent proviso in the terms of leasing that allows an authority at the division level (possibly upon the recommendation of DoF or MFF) to extend the lease of the current lessee. In this situation the lessee would be judged to be managing their lease well and possibly even enhancing the production. The cost of the lease is generally relatively low and in cases where leases are renewed; there may be an annual incremental increase of 10 percent.

Fishery management

The mission visited several leasable fisheries locations that represented a range of management methods and habitat types. Leasable waters are mostly seasonal floodplain waters that recede into smaller permanent water bodies or dry up completely. Almost all of the leasable fisheries visited are productive although not typical of leasable fisheries that are reliant on wild recruitment. The productivity is due to the enhancement and management activities of the lessees.

Some leases in urban areas have been dammed and are now permanent water bodies. In two cases the proximity to urban areas and the inevitable drainage of domestic sewage/runoff greatly increased the productivity of the water.

One of the key factors that was evident to the Mission was that although leasable fisheries is managed by the lessee, all the fisheries provide a direct livelihood for a minimum of 40 to 60 families; these families are engaged in fishing, securing the resource, nursing, preparation of the water body if required and marketing. Moreover the families are drawn from the nearby village(s) and thus there is some spread of benefits into surrounding communities.



“The price (of fish) is increased, the supply is less, the environment is more degraded, there are pesticides from floating vegetable gardens (in Inle Lake), and more sediment”. HDI Programme Manager Nyaung Shwe, Shan State.

All of the leasable fisheries visited were questioned regarding the manner in which illegal fishing/poaching of fish was controlled. The lessees had various capacities to control this depending upon the size of their leasable fishery, the number of people paid to patrol and control, and the population density in the lease area.

In a small leasable fishery, poaching was controlled by patrolling and guarding to deter the activity. Where fishers were caught fishing illegally action may or may not be taken depending upon the frequency of the infringement or the scale of poaching. It is likely that poaching at a level that incurs significant catches is probably dealt with severely. All of the leasable fisheries sites seemed to tolerate a level of fishing by local people since it is essentially impossible to prevent. There is therefore not complete exclusion, but at the same time there are certainly limitations on the local population from accessing the resource.

It was evident to the Mission that the improvements that have been made to the culture-based fishery practices of the leasable fisheries have been rather limited with some notable exceptions. Typically, the lessee has been complacent with the production levels, and that very few, if any, trial and error changes have been made to improve the production. Any changes that have been made have been mostly physical/ structural.

In this respect, there appears to be considerable scope for further enhancement of these fisheries through stocking of advanced large sized fingerlings, using appropriate stocking rates and possibly strategic feeding in some of the smaller leases.



Sub-leasing

Sub-leased lake-based fishing, such as the unique ‘saung’ trap (opposite) used by Intha fishers on Inle Lake in Shan State provides a livelihood for canoe owners for an annual fee of K1 000. Fishers can fish every day and sell their catch at K600/Viss.

Thaung Tha Man – Mandalay

In the case of this fishery (600 ha; permanent water body), which is so large that effective control is impossible, a system of engaging the local population in the activity had been initiated by the lessee. The lessee has introduced *Oreochromis niloticus* into the water body and now this species contributes nearly 60 percent to the total production (estimated at 2 800 kg/ha), the rest being stocked species such as *Labeo rohita* and minor, indigenous cyprinids, gobids, etc.

The lessee has developed an effective system of exploiting the fish resources and a marketing strategy which engages the community in the exploitation of the resource. The local men involved in the fishery activity and the women of the villages were involved in the subsequent marketing of the catch. Since this is an interesting case of management through involvement rather than exclusion, this is worth explaining further.

There are netting crews (2 crews) employed by the lessee who receive 20 percent of the catch to dispose themselves either by consumption or by sale to the lessee. The majority of fishers are not part of the netting crew and they sell their catch directly to the lessee at one of four landing stations. The prices paid in all cases are below the market rate, but the sale is guaranteed and convenient. The sale of the fish from the landing stations appears to be on a quota basis with women from the local villages (approximately 1 500 in total) queuing up for a fixed 15 kg of fish to sell. The sale price is below the market rate and the women can make a mark up (approximately 15 percent) when they sell at one of the many small markets in and around Mandalay. At the landing station

visited by the mission over 100 women were waiting to purchase fish and all transactions were made in cash, indicating that a book or loan system was not operating.

Apart from involving the local communities in the exploitation of the resource, the lessee has also introduced protected areas that have been identified as tilapia breeding grounds and also releases some other species. There is a certain amount of feeding at the time that the lease floods, allegedly to prevent fish from migrating from the lease).

In total it is estimated by the mission that this leasable fishery provides the livelihood for nearly 5 000 persons living in the vicinity of the water body.

Mandalay town

Another leasable fishery in the heart of Mandalay, Kan Daw Gyi (300 ha; permanent water body) has adopted an exclusively stock (2-3 million fingerlings.annum⁻¹) and recapture system (500 000 to 600 000 full grown fish.year⁻¹). Species harvested are bighead carp (3-4 kg size) and silver carp (2-3 kg size) as well as major Indian carps. The yield from this leasable fishery is about 4 200 kg/ha. This leasable fishery is now treated as a pond, and accordingly a license fee of 45 000 kyats is levied from the owner. This lease has experienced fish kills in the past, and the current practice of feeding 3 tonnes/day needs to be given serious consideration, as this practice is bound to exacerbate the nutrient load of this already eutrophied water body. It could be that the present production could be achieved with a significantly reduced feed input, and consequently not only make the fishery more cost-effective but increase the possibility of reducing the price to the consumer.



Livelihoods from leasable fisheries

Large-scale fisheries of 10s to 100s of acres are leased, via auction, to those with means to operate and sustain them. Lease holders are required to manage these as cultured-based fisheries.



Involving the community and spreading benefits

Leasable fisheries such as this one at Thaug Tha Man in Mandalay Division represent a decentralized management system for large fisheries and are the main income generating activity of the Department of Fisheries.

South Mandalay

The Mission visited what could be considered as a typical leasable fishery, a non-perennial flood plain water body, in its eighth year of lease, with a water spread of 222 ha at full flood level. The fishery is culture-based, primarily depending on common carp. Currently, the fishery yields 680 kg/ha, of which the stocked fish account for over 98 percent.

Inle Lake

Inle Lake, Shan State is the second largest natural inland water body in Myanmar. The township of Nyaung Shwe, encompassing 451 villages surround the Lake. The Lake provides the livelihood for about 460 fisher families and many “floating garden” agriculturists, and service providers such as boatmen. Importantly, the Lake provides the main animal protein source (as fresh and dried/preserved fish) for the township populations and the surrounding townships.

Production from the lake is estimated to be about 550-650 tonnes, representing a production of about 20-25 kg/ha/yr, which is about the expected level of exploitable production from a mesotrophic water body. The main fish resources appear to be snakeheads (*Ophicephalus* spp.), murrels (*Channa* spp.), featherbacks (*Notopterus* spp.), *Wallago* spp., spiny eel (*Mastacembalus* spp.), common carp. Fishers also exploit *Rasbora* spp., *Puntius* spp. (e.g. *P. dorsalis*), attid shrimps, etc., using traps and cast nets, the bulk of which is salted and sun-dried, and sold.

It is apparent that fish species occupying all the trophic levels are exploited, irrespective of size and or species. However, what was evident was that the number of gear types are extremely limited, the main ones being moveable, drop traps

Inle lake

Small traps are set also in larger lakes such as these being transported across Inle Lake (Shan State). Small fish play a valuable role in food security, providing essential minerals such as calcium, iodine (goitre is a common debility) and sulphurous amino acids, complementing protein from rice based diets.





This canoe owners at Inle Lake claims hook and line gear provides a better return for the same K1 000 annual fee. This man will leave his 200 m line (with hooks at meter intervals baited with shrimp) overnight every day of the year. Best catches are in April.

(‘saung’), small stationary traps, cast nets, long lines (baited) and gill nets. In addition, the lake also provides the livelihood for an unknown number of weed collectors for grass carp farming inland.

The lake, which is purported to have a relatively unique flora and fauna, that includes two finfish genera (Chaudhuri, Sawbwa) and seven species endemic to the Lake (Annandale, 1918), is fast changing in character as a consequence of the large scale establishment of floating gardens for soft vegetable production. There is also development of the northern part of the lake where excavation of sediment to reclaim land for industrial scale horticulture/agriculture is commencing. Such expansion and intensification is associated with high fertilizer use and pesticide use, the latter capable of influencing the nutrient loading and thereby the trophic status of the lake.

Although it is difficult to predict the outcome of these changes, particularly on the fishery, it is almost certain that the rooted, aquatic weeds (predominantly *Charra* spp.) will disappear due to light limitations due to planktonic growth, and hence affect the livelihood of the weed collectors directly, and the inland grass carp culture indirectly through the limitation of a readily available food source. In addition, it could also influence the newly established bird sanctuary, through a reduction in the diversity of the avian fauna over the years.

Open fisheries and rice field resources

All fishing gears require a license from DoF, although in practical terms it is difficult to collect license fees from all the small gear holders. There is widespread fishing activity in water bodies, streams, lakes, reservoirs and rice fields. These activities may be legal or illegal depending upon the location and the existence of fishing regulations or lease holding.

It is currently unclear as to the extent of fishing activities in the open fisheries as these are often occasional, seasonal and may or may not be strictly legal. The DoF has little opportunity to gather information on this dispersed activity and tends to accept that fishing for household purposes cannot and need not be regulated.

This gives rise to the situation whereby it is unclear as to the extent of participation in this activity and whether or not it is a significant part of rural food security or rural livelihood strategies. If comparisons are made with the other Southeast Asian countries then it would be expected that this resource is in deed a vital part of the household livelihood and especially for the rural poor. Myanmar has extensive ricefield resources and associated channels and streams. This network of water and shallow flooded paddy is a rich source of fisheries production, although since it is the jurisdiction of



Artisanal fishing

Small-scale yet widespread. Artisanal fish trap operations contribute to livelihoods of poor women and men (see discussion of poverty in Myanmar). A traditional Myanmar saying “Eat 100 heads” describes the virtue of consuming a diversity of products for good nutrition. In this regard small fish are especially popular amongst many Myanmar, Shan and Inle people.

Table 4: Description of the leasable fisheries visited by the mission

Location	Years of leasing	Management interventions	Cost of lease (Kyat/yr)	Area of leasable fishery (ha)	Estimated Production (tonnes/yr)	Approx. value of production
South of Mandalay	8	<ul style="list-style-type: none"> • Small seasonally flooded area • Agricultural activities take place in the dry season. • Release of nursed advanced 3-4" fingerlings which also comprise a large proportion of the subsequent catch. • Harvesting of fish • Guarding/patrolling • Supplemental feeding (1:1 rice bran & oil cake) • Employs 40 people 	500 000	222 ha	151 tonnes (680 kg/ha) Bad season 100 tonnes (450 kg/ha)	\$30 000
Mandalay Lake	9	<ul style="list-style-type: none"> • Stocking of advance fingerlings Chinese and Indian carp (2-3 million per year) • Feeding at 3 tonnes per day, 50 percent of income • High natural fertility from urban runoff into the lake • Netting crews, continuous harvesting 	45 000	300 ha	1 260 tonnes (4 200 kg/ha)	\$630 000
Thaung Tha Man	9	<ul style="list-style-type: none"> • A huge lake with permanent water. • There is some stocking of nursed 4-5" fingerlings (1 000 000/yr) in accordance with lease regulations. • Operates a 5 ha nursery pond for this purpose • Tilapia have been introduced and form the bulk of the catch. • There is demarcation of some Tilapia breeding grounds and fishing in these areas is not allowed • Some of the species released are re-caught. • Distribution of free fishing gear to villages surrounding the lake • Two Catching teams are employed with a 20 percent of catch bonus • Other fishers can catch but must sell to the landing stations • Purchase of catch at 4 stations paying lower than market rates • The onward sale of the catch to the wives of the fishers/local traders for resale in markets surrounding Mandalay town. (each gets 15 kg) 	5 000 000	600 ha	1 680 tonnes (2 800 kg/ha)	\$840 000
Inle Lake	—	<ul style="list-style-type: none"> • The lake is divided into two leasable fisheries • MFF holds the lease in two and sub-leases to about 300 fishermen at 1 000 Kyat/yr 	100 000	27 000 ha	>550-650 tonnes (20-25 kg/ha)	\$550 000



Setting of small bamboo and basket traps by women and men in wet paddy and small water courses catch valuable small fish (e.g. Amblypharyngodon, Ophicephalus, Rasbora and barbs). Catches can be a few fish up to 2 Viss/day. (1 viss = 1.6 kg).

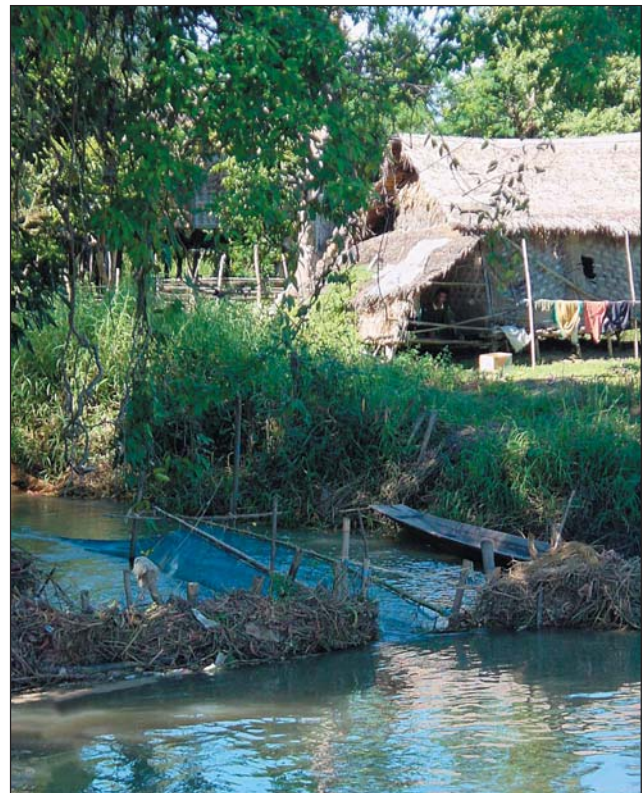
the Department of Agriculture and Irrigation, the Department of Fisheries does not have any data regarding the fisheries production of these environments.

Enhancement of freshwater leasable fisheries/culture-based fisheries

Myanmar also has extensive capture fisheries in its freshwaters and these are either leasable or open fisheries. As part of the regulations covering the leasable fisheries lessees must release some fish to their lot. The effectiveness of this is undoubtedly variable since the size of the fish released and the environment into which it is released will determine greatly the likelihood of survival of the fish. As a general rule, the larger the fingerling released the greater the chances it will survive long enough to be recaptured. In one leasable fishery visited the recapture of the same species as those stocked by the lessee was a strong indication of the potential of this form of management and was considered to be related to the size of the fingerlings stocked.

A common form of aquaculture is related to enhancement of culture based fisheries or leasable fisheries. As part of the regulations concerning leasable fisheries, fish fingerlings must be released to the fishery. The lessees therefore purchase fry or fingerlings and nurse prior to release to their fishery sites once the flood waters have risen. The impact of this activity on the productivity of the leasable fishery is probably variable.

The mission visited one site (Su Sann Inn, perennial water, 48 ha) where the fish returned were almost entirely of the species stocked (Rohu and common carp). The stocking rate was about 0.4 piece/m² and the size at stocking was an advanced fingerling of about 5". The yield was



Licensed gears

Larger gears, like this stream trap (Nyaung Shwe, Shan State) provide more visible livelihoods and are licensed by the Department of Fisheries. They are therefore recordable and can be strategically managed by government. Such systems set below paddy land can capture up to 75 kg/day during peak months (e.g. November-December) prior to the rice harvest. In the market Ophicephalus bring K700 and Amblypharyngodon bring K800/Viss.

Su Sann Inn, Mandalay

Before setting up his 160 tonnes carp farm, this farmer went to the DoF everyday to learn fish farming. “My wife’s parents are ‘middlemen’ in the fish trade and encouraged me because demand for Rohu could not be satisfied in this region”. Su Sann Inn, Ta Mar Kone Village, 27 Miles from Mandalay.



approximately 3.3 tonnes/ha, with total harvest reaching 160 tonnes.

In other leasable fisheries where small fingerlings were released or the numbers released were insignificant relative to the area of water, there was little indication that the fish stocked were being recaptured and the catch was mainly self-recruiting species or wild fish species – suggesting that the impact of stocking was limited.

The mission was of the opinion that the culture and release of advanced large sized fingerlings does enhance leasable fisheries catch and is responsible for the quite high catches that are obtained from them. However, there had not been any cost-benefit studies on stocking of these large waters in Myanmar, and the economic rationale of the activity remains unqualified.

Reservoirs

Reservoirs are rarely built for fishery purposes. However, fisheries are a significant user of reservoir water resources, and increasing emphasis is being laid on reservoir fisheries development, particularly in developing countries, almost without exception, such as for example, India, Indonesia, Thailand, Sri Lanka, Viet Nam, etc. The primary reasons for such a developmental emphasis are:

- Increase the fish supplies to the community, often at an affordable price, and thereby increase the nutritional status of the poorer sectors of the community,
- Provide a means of livelihood to a significant number of families living in the vicinity of reservoirs, and
- An effective means of utilizing natural productivity of water bodies, with out perceived direct environmental degradation, for community benefit.

The reservoir resource in Asia is the highest in the world, and reservoir fish production in Asia contributes significantly (80 percent), and increasingly to the estimated global inland fish production of about 10 million tonnes. Asian countries that until recently did not have major programmes for reservoir fisheries development have embarked on such programmes, as for example in Viet Nam; the Government of Viet Nam expects to increase reservoir fish production to 250 000 tonnes by year 2010 from 50 000 tonnes at present.

Myanmar has very large lake and reservoir resource estimated by DoF at about 115 867 ha. Previously, reservoir fisheries were encouraged in Myanmar, and it provided the livelihood for many thousands of families, and contributed significantly to the rural fish supplies, as well as contributed to the national revenue through the revenue generated from the issue of fishing licenses.

However, since 1995 fisheries activities have been banned through a decree by the Department of Irrigation which has jurisdiction over all reservoirs in Myanmar. The Department of Fisheries nevertheless continues with a reservoir stocking programme of Indian and Chinese major carps for conservation purposes.

DoF does not include reservoir catches in its current reports since it does not collect license fees. The Mission had the opportunity to visit only one reservoir (in Upper Myanmar; Se Dew Gyi Reservoir; 2 890 ha; impounded in 1986/87) and had discussions with some fishers. It transpired that there was some degree of fishing in the reservoir, but to a very much lesser extent prior to the issue of the decree of banning fishing. Although fishing continues on reservoirs, it is considered only for home consumption and also nominally allowed only for families that have a livelihood in the area. Consequently, this “illegal” fishing for household purposes not only deprive the Government of Myanmar of revenue,

but inevitably means that the fishers are operating in a manner that is likely to affect fishing efficiency and marketing strategies.

Even if a production level, as low as 150 kg/ha is used, the reservoir fishery resources of Myanmar should yield about 17 350 tonnes of fish per year, and also provide employment opportunities to at least 20 000 to 30 000 persons in the rural areas.

It was unfortunate that the Mission was unable to obtain copy of the decree banning fishing nor documentation of the underlying reasons for the decree issued by the Department of Irrigation. The numerous discussions that the Mission had with officials, fishers and persons knowledgeable on the matter indicated that the decree has been issued for the following reasons:

- The perception that fishing could physically affect the reservoir and/or the dam and
- Fishery activities in the reservoir would deprive the fish availability to farmers in the command area through the spill-over of stocks from the reservoir to the command area.

Based on the experiences of other nations which continue to have well developed reservoir fisheries, for more than 50 years, it is concluded that fishery activities in the reservoir would have little or no relationship to the fish availability to farmers in the command area. Reservoir fisheries are considered one of the least environmentally invasive forms of fishery and should be encouraged. This is an area which could contribute significantly to total fish supplies. It is the conclusion of the Mission that fishing activities will not physically affect the reservoir or the dam.

Based on the above reasons the Mission is of the view that Myanmar should take steps to reintroduce reservoir fisheries, initially on a small scale, and in conjunction with the

irrigation authorities, and over time, supported by research, evolve suitable strategies to optimize yields, including the cost-effectiveness of any proposed stocking programme that is to be included, and sustain it in the long term.

Freshwater aquaculture

Freshwater aquaculture contributes to the economy of Myanmar in a number of ways. The production of fish fingerlings and stocking into aquaculture ponds is the typical form of aquaculture and is currently practised for a range of species. This is also the form of aquaculture that is promoted by the DoF along with some cage aquaculture. Typically the aquaculture operations that were observed by the mission were over 1.2 ha and were not of a type that could be widely adopted by Myanmar farmers in general, due to the scale and the requirement for capital investment.

Some small operations visited (in Mandalay and Shan State) had been constructed over a number of years by the owners, investing the opportunity cost of their time and typically converted their compound gardens (in Mandalay) or marginal/abandoned rice fields.

Land use for aquaculture

The strict control by the agriculture department regarding the conversion of rice lands into other uses (especially aquaculture) is one of the strongest restraints to more widespread development of aquaculture in freshwater areas. Paddy lands flat and typically inundated by flooding or rainfall for rice cultivation. Paddy land also has few alternative uses for agriculture because of the tendency to be covered in water for parts of the year. Aquaculture is one of the few activities that are profitable enough to repay the cost of conversion of paddy (through raising earth walls and excavation into ponds). In areas where the profitability of rice farming is quite marginal, fish pond aquaculture can be an attractive alternative.



Se Dew Gyi Reservoir 2 890 ha
Previously, reservoir fisheries were encouraged in Myanmar, and it provided the livelihood for many thousands of families and contributed significantly to the rural fish supplies, as well as contributed to the national revenue through the revenue generated from the issue of fishing licenses.

“I went into fish hatching because I knew it was good business” – Small Farm Owner, Baw Ri Tha Village, Taungyi District, Shan State.



Rice-fish culture

The DoF in response to the need to improve income from paddy farming, whilst still maintaining some rice production, DoF reports that it has had nominal approval from the Ministry of Agriculture to start experimentation with the culture of fish in rice paddies. Rice-fish culture has a very long history in most of Southeast Asia and there is a great deal of information available regarding the various reasons why it has been successful in some circumstances and failed elsewhere. The success of rice fish culture is extremely variable and relates to the reliability of water supply, control of theft, prevention of flooding or escape of the fish and the availability of large sized fingerlings at the start of the paddy culture season. In a country such as Myanmar, where the wild fisheries resources are still very extensive, the presence of large numbers of carnivorous fish in the paddy fields is another cause of poor return from stocked fish. This is generally avoided by the stocking of large fingerlings but this adds another step in the culture process and increases the overall cost of stocking making it unattractive to some farmers.

Ultimately rice fish culture can only be tried in a practical situation and the impacts evaluated, ideally with the participation of farmers so that any results are grounded in the realities of their farming systems (i.e. participatory/farmer based research).

Pond aquaculture

Pond aquaculture in Myanmar is set against a Buddhist tradition of non-culture of fish (religious avoidance of cruelty to fish) and unwillingness or preference not to kill animals. It is apparent though that freshwater aquaculture is increasing and is growing fastest where ethnic Chinese are becoming involved since they do not have this cultural avoidance. The ethnic Chinese are also able to raise the input capital for aquaculture development more readily and also have access to information and technologies from China.

Government of the Union of Myanmar has formed a State level committee to facilitate a three-year project of fresh water fish production through aquaculture. This is directed towards sustaining food security (freshwater aquaculture and enhancement of fisheries) and increased export earnings (principally shrimp aquaculture but also some freshwater culture and brackishwater aquaculture). The goal of this is to increase fishpond area up to 40 650 ha (100 000 acres) at the end of the project.

The size of aquaculture ponds observed in Mandalay province are rather large and may be constructed or more likely converted from low lying or flooded ground. There were reports of large numbers of small-scale ponds but the mission did not observe many and this can only be speculated upon. In Shan State a number of smaller fish culture operations and hatcheries were visited, but these still occupied water areas of over 1 hectare.

There is no record of small pond holdings because this information is not collected and ponds less than 8 m x 8 m do not require licensing. Based on the observations of the Mission, there appear to be very few small (less than 400 m²) fish pond operations. This is unusual relative to other countries of Southeast Asia, where small ponds are quite popular, but may reflect a cultural reluctance to farm fish (unlike the ethnic Chinese in Myanmar, who readily engage in fish culture), or possibly uncertainty over the legality or potential of small scale fish culture. Another possibility is that wild fish are sufficiently available to lowland rural people to render fish culture in small ponds unattractive.

Identification of the underlying reasons for this would have significant implications for aquaculture development in rural areas especially where the rural poor are targeted. It is recommended that this be clarified and documented.

Freshwater species cultured in Myanmar

Typical aquaculture ponds are stocked with a number of species on an annual basis. The favoured species are Rohu and common carp, although some tilapia may also be found in larger ponds. Grass carp are also cultured in Shan State, since they are easy to feed and there is a market with the ethnic Chinese communities. Some market prices are shown in Table 5.

Stocking and harvesting

Fingerlings may be nursed to larger sizes before stocking by the owners and there is also nursing of fingerlings prior to release to culture based fisheries and leasable fisheries. Prices vary with the regions although a typical price for 0.5-1” fish was 3 kyat each.

In ponds with perennial water harvesting may occur after a period of one year and in some instances a year and a half. There is a growing tendency to produce smaller table sized fish than the larger (0.2 kg) fish that were previously produced which shortens the culture period. This also allows the marketing of fish during the season during which there is a shortage of fish from the wild fisheries due to the closed season (May-June).

Typical stocking densities are about 0.5-0.8 pieces/m² but there is reportedly and trend to increasing stocking density that is part of the reduced size at harvest. The source of fingerlings is varied – either from the government hatcheries (there are four in Mandalay division, none in Shan State) or from a number of small-scale private hatcheries (Shan has three private hatcheries and will shortly have five due to a rapidly increasing demand from development of aquaculture ponds at the northern part of Nyaung Shwe).

The greater availability of fingerlings in this area may further stimulate aquaculture pond construction further away. The

ready availability of fingerlings is a strong driving force for aquaculture development especially when coupled to improved road communications and access to markets.

The breeding of fish using hypophysation is reasonably routine in Myanmar government hatcheries and there is now access to Chinese fish-breeding hormones (HCG, Luteinizing hormone and possibly LHRHa). This allows the mass spawning of the Indian and common carps and also unseasonal/repeat-breeding of common carp. Small-scale hatcheries can also obtain the breeding hormones but may tend towards the use of carp pituitary which they can produce themselves.

Government hatcheries

There are currently 16 DoF hatcheries located in 5 divisions and one state. DoF estimates of fingerling production are difficult to interpret as no distinction is made between fry (typically 7 days post hatching) and fingerling (0.5-1” or 4-5”) production.

The release of 7 day old fry to natural waters is considered to have questionable benefits since the survival rate of such small fish can be expected to be so low as to have no significant impact on the fish population already presenting the water body.

The DoF hatcheries produce both fingerlings for stocking out in aquaculture and for sale to leasable fisheries. These are typically 0.5-1” in size and there is usually some onward nursing by the buyer.

A DoF estimate of its hatchery production is approximately 398 million fry (size unspecified) of which 98 million were destined for fisheries enhancement. Private sector production is considered far higher at 700 million from 3 hatcheries and there are about 54 private hatcheries operating nationally (Win Lat, 2002). The considerable vagueness of reporting

Table 5: Prices of cultured freshwater fish in Shan State and Mandalay Division

Commercial scale		Mandalay Kyat/kg	Shan Kyat/kg
Rohu	<i>Labeo rohita</i>	–	480
Mrigal	<i>Cirrhinus mrigala</i>	600	–
Catla	<i>Catla catla</i>	–	–
Common carp	<i>Cyprinus carpio</i>	200	720
Grass carp	<i>Ctenopharyngodon idellus</i>	–	480
Silver carp	<i>Hypophthalmichthys molitrix</i>	–	–
Big head	<i>Aristichthys nobilis</i>	–	–
Snakehead spp.	<i>Channa spp.</i>	–	980
Tilapia	<i>Oreochromis spp.</i>	480	–
Hybrid catfish	<i>Clarias gariepinus x C. macrocephalus</i>	–	700
Striped catfish	<i>Pangasius hypothalamus</i>	–	–
Great white sheatfish	<i>Wallago attu</i>	1 350	–
Experimental			
Freshwater prawn	<i>Macrobrachium rosenbergii</i>	1 400	–
Local barb	<i>Rotee cotio</i>	–	–
Pacu	<i>Collosoma</i>	–	–
Thai Silver Barb	<i>Barbodes gonionotus</i>	–	–

Small-scale hatcheries

Small-scale hatchery and nursing supplies not only Mandalay and the surrounding area but buyers even come from surrounding states to purchase – additional services are provided such as technical and market information.



of hatchery production is quite typical and the number of hatchlings is only a vague reflection of the number of surviving fingerlings that are stocked into aquaculture or released to fisheries.

Private hatcheries

The mission visited several small-scale private hatchery operations. These operations are producing common carp and Rohu at both fry and fingerling size for sale to aquaculture pond owners and the owners of leasable fisheries (particularly in the northern parts of Mandalay division and further). In Shan State there was demand for common carp and grass carp and these were being produced for stocking both local ponds and for export to Yangon.

The hatcheries have different strategies for production either producing their own fry or purchasing fry from the DoF hatchery and nursing on for sale. The small private operations produced about 1-1.5 million fingerlings annually and a substantially greater number of fry (50 million).

These private hatcheries compete for markets with the larger DoF hatcheries (where DoF hatcheries exist), but have a number of mechanisms by which they can provide additional services to customers – one hatchery provided accommodation for customers that lived far from Mandalay, another provided (for a price) a pump rental service for draining and filling ponds. These types of services are crucial for smaller farmers that cannot afford to purchase capital items. In addition to this the experience of the hatchery owners is often greater than that of their customers and they also provide advice on the culture of fish as well as advice on harvesting times and likely markets. The four sites visited ranged between were 2.0-2.8 ha.

The entry into the hatchery business has been gradual and both owners mentioned that they had started as fish pond

owners and gradually developed the hatchery business as they realized the profit return for a small site was greater if they focussed on hatchery and nursery activities.

Feeds and feeding

According to information available to the mission, typical productivity of aquaculture ponds is about 1.0-3.5 tonnes/ha depending upon the level of stocking and feeding. Feeding of aquaculture ponds is variable with tendency to supplemental feeding of rice bran and agricultural by-products. Some farms are integrated with livestock (principally chickens) production but these are certainly a minority.

The production of significant amounts of Rohu, tilapia and common carp as well as other cyprinid wild fish from the leasable fisheries in Mandalay inevitably means that cultured fish compete in the same markets. This means that there is a relatively low price for tilapia, Rohu and common carp (typically 600-800 Kyat/kg) and this makes high investment in aquaculture unattractive. Since market prices are low, the investment in feeds and fingerlings must be equally low and hence the intensity of production and use of pelleted feeds is limited.

There is one feed mill in Mandalay (in upper Myanmar) producing fish pellet feeds with a capacity of 75 tonnes per day although it is currently producing less than this due to lack of market demand. The quality of the feed is low (claimed to be >27 percent crude protein, <percent fish meal/dried fish content) and it appears to be used only as a supplement. In the future, the development of further demand for aquacultured fish, expansion of culture into higher value species may increase demand for fish feeds. It is also important that as demand for improved fingerlings for stocking into aquaculture ponds or for release to water bodies, the need for better quality feeds will emerge.



Fresh fish sellers – Nyaung Shwe

These women bring 40 kg/day to the main market. The rising demand and cost may limit access to fish for more remote people who depend also on the lake resources for their fish protein. Iodine deficiency is quite prevalent.

There is a period during which the leasable fisheries are closed (April to June) and at this time the price of fish rises. Aquacultured fish have a window of opportunity to exploit the shortage of fish and some operators may schedule harvests to exploit this advantage. Larger riverine fish (Wallago, larger cyprinids, *Pangassius* like species) command a higher price (1 000-1 200 Kyat/kg) and there is some interest to culture these species.

Marketing

Inle Lake fishery and marketing

In Shan State, community markets are held on a traditional rotating basis, in which every town within a given area hosts a market every five days. At Nyaung Shwe market and Nam Pan market at opposite ends of the Inle Lake, women gather to sell their fish, totalling around 1 tonne for the day. Some bring fish they have caught with basket traps and hook and line that day or the previous day, others have purchased from fishermen. Two women from a village on the eastern shore who operate together have 10 kg of fresh fish, mostly snakehead both large and small and catch and sell fish twice in 5 days. The women have no scales and sell the fish strung together in groups. Their catch is worth US\$ 16 and represents 4 days effort earning them the equivalent of 1.14 US\$/day nearly three times the average daily expenditure for Myanmar of US\$ 0.44 (as reported in

Statistical Year Book, 1998). Some women who sell all their fish return with a second batch sometimes selling 40 kg in the day.

Institutions and their roles

The role of the Department of Fisheries (DoF)

Recent history

Fisheries were recognized in the late 1920's and early 1930's as an important provider of income and employment and as a source of revenue to the colonial administration. The 1931 Census of Burma, reported that the industry employed 55 000 full time fishers as well as 16 000 part-time. According to the Department of Fisheries, administration of aquaculture originated in 1954 when the Agriculture and Rural Development Corporation (ARDC) set up an Aquaculture Section, starting with a station in Yangon. Tilapia (probably *Oreochromis niloticus*) was introduced from Thailand and cultured locally. By 1956, ARDC had established 100 fish farms. Aquaculture expanded via the capture and nursing of wild-caught Rohu, Catla and Mrigal fingerling (collected June-October and nursed by ARDC). The Corporation also conserved the spawning grounds of these species especially in Thrawaw, Hinsata Shwe Daung Pyae townships in lower Burma and Mandalay district and Amarapura (Mandalay), around Myit Ngae river and Sintgu areas.

In 1964, common carp were introduced from Israel and Indonesia for aquaculture. Their growth rate was greater and they proved popular for culture. In 1967, with the support of FAO, induced breeding of Rohu was established. In 1990 hybrid Clarias was introduced to Myanmar and in 1994 *Pangasius* culture was initiated. There remains a government focus in freshwater aquaculture with induced breeding of Indian major carps, as well as grass carp, big head carp, silver carp and common carp.



Aquaculture support industries

This feed mill in Mandalay produces a low quality fish feed for supplementing pond culture and the owners leasable fishery. Improvements in feed quality might be targeted at nursery production for stocking into aquaculture ponds and leasable fisheries.

Current role

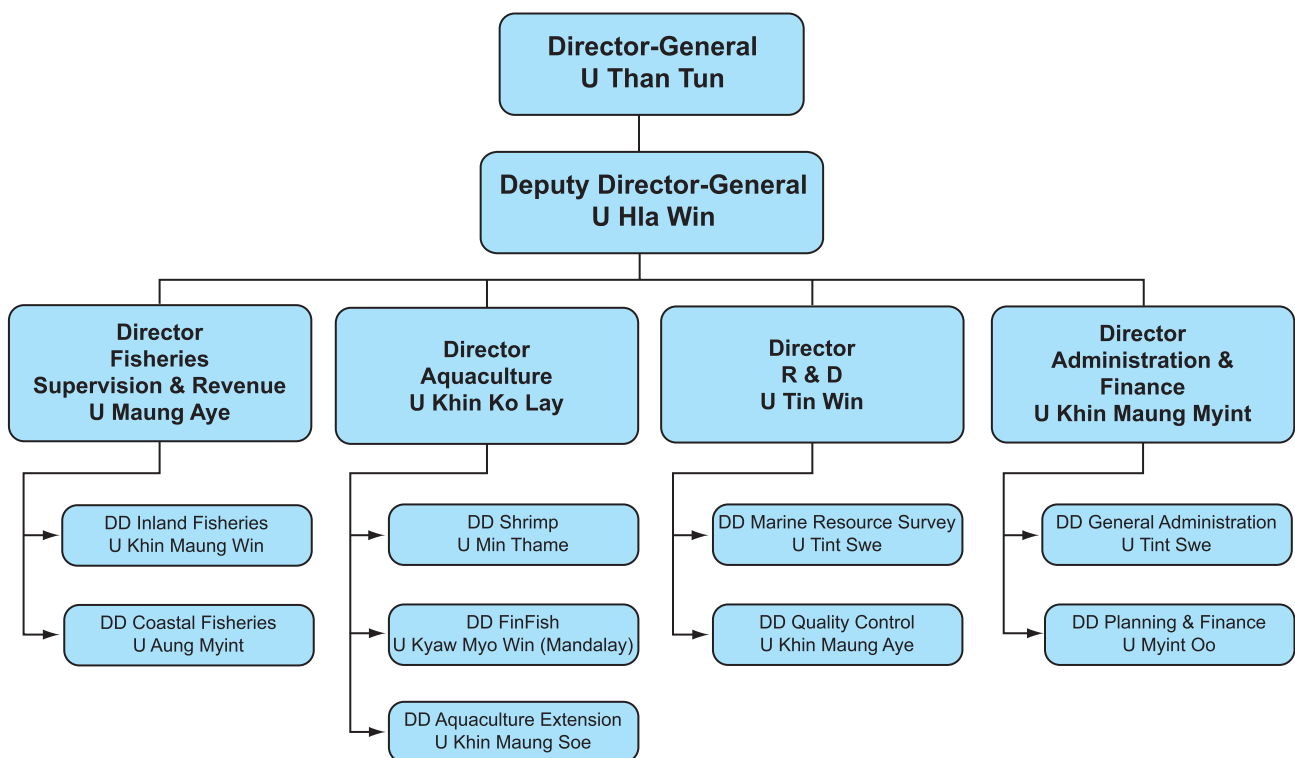
The Department of Fisheries in Myanmar comes under the Ministry of Livestock and Fisheries, its key role being the management of fisheries and aquaculture. The Department was reorganized in April 2002 to better address the increasing importance of aquaculture in Myanmar. However its size and the scale of resources for the Fisheries Department does not reflect the central importance of fish in Myanmar, both in terms of its expanding economic contribution and the contribution it makes to food security nutrition and livelihood opportunities. The new administrative structure has four directorates dealing with capture fisheries, aquaculture, research and development and administration (see DoF Organogram, Figure 1). Some roles are cross-cutting whilst others relate to fisheries or aquaculture administration; they can be summarized as follows:

- The issuing of licenses for fisheries gear/vessels/sites and aquaculture sites/ventures.
- Evaluation of sites for aquaculture or fisheries.
- The production of fingerlings for sale to aquaculture and leasable fisheries (revenue generation) and stocking of Open Water Fisheries (reservoirs, rivers and other water bodies including community ponds)
- As an advisory body to the Minister of Livestock and Fisheries and the Divisional and State Government on fisheries and aquaculture matters.
- As a regulatory body for the correct and proper conduct of fisheries and aquaculture (i.e. inspection of fishing gears/sites).

- As an inspection body for the fish trade (i.e. inspection of legal size of export products, quality assurance and certification, etc.).
- Administration of the system for the auctioning of Leasable Freshwater Fisheries (the auction price of the lease is collected by DoF). This is a key income generating activity from the inland fisheries sector.
- Stocking of Open Water Fisheries. This is performed in a number of ways ranging from the release of millions of 7-day old fish fry (typically Rohu) to the release of larger (0.5-1”) fingerlings. (e.g. one hatchery may release up to 50 million fry to natural waters).
- Administration of water bodies for aquaculture including so-called virgin land, degraded agricultural lands, perennially flooded areas, small dams, village ponds, borrow pits near roads and houses, spill water from irrigation, feasible cage culture sites in rivers, rice fish, environment friendly mangrove culture, salt pens (in rainy season), barge and raft culture in brackish and marine areas.
- The collection and communication of aquaculture knowledge (under the Deputy Director for Aquaculture Extension).
- Training/extension.

The national DoF office in Yangon has a staff of about 1 000, whilst the State and Divisional Fisheries administration varies with the importance of fisheries locally. Mandalay Division which is an important fish production centre for Upper Myanmar has 4 Fisheries Stations. Thayetkone Fisheries Station near Mandalay town is an example, which has a staff

Figure 1: Organogram for Myanmar Department of Fisheries (12.2002)



of 35 engaged in carp hatching, restocking, fingerling sales, training and to a limited extent extension.

There is typically one DoF officer per 3-4 townships (and this officer does not usually have a vehicle). The officers will check fishing gears, mesh sizes and licenses. In Shan State, all 20 DoF staff currently operate in the south of the state west of the Thalwin River, 18 of whom monitor the Inle Lake and two others work further east.

Aquaculture Development and Stock Enhancement planning in Myanmar

The first plan produced for aquaculture in Myanmar was written as a project spanning 2000-2003. It remains unclear if this will become a regular, perhaps 3-yearly, planning process. The stated objectives of the plan are quoted directly as follows:

1. To set up aquaculture of fish by government and the private sector to increase production per acre, to expand fish ponds and to distribute suitable species for states and divisions.
2. To increase the fish consumption amongst local people nationally.
3. To upgrade the style of fish eating so as to support the wellbeing.
4. To initiate and expand marine fish culture (as most marine fish have an export market).
5. To expand production of other freshwater fish which have an export market.
6. To conserve the freshwater fish resources in man-made, natural and marine water bodies and
7. To increase and sustain overall production, especially via stocking of seed.

Implementation procedure for the current 3-year national 'plan for aquaculture' involves upgrading fish farming methods, looking at feasible methods in relation to conditions, monitoring effectiveness, supporting access to electricity and fuel, and safeguarding fish farmers. This will take place in the context of sustaining and increasing natural stocks, reviewing internal and export markets and identifying the best methods for improvement.

The 3-year plan is 'projectised' and target based, with targets for fry and fingerling production, for seedlings distribution in natural water bodies, coastal aquaculture and brackish water stocking, fish hatchery expansion and the development of research programmes and demonstration sites. An example is that Fish Farm Number 2 in Upper Myanmar has stocked 12 million fry this year and sold 52 million for aquaculture and leasable fisheries, (which exceeds the project target). In open waters the DoF stock 100 fry/acre, including, popularly, into communal village ponds.

Based on experience elsewhere in the region which suggests there was negligible enhancement effect from stocking fry into natural waters, the mission is of the opinion that the stocking of 7 day old fry is unlikely to have any enhancement effect on a natural water body. Successful enhancements are typically found with the stocking of nursed fish of a larger size (>4 inches), as practised by some of the leasable fisheries visited by the mission.

It is recommended that more nursing of stock for enhancement be undertaken by DoF stations to increase the effectiveness of enhancement programmes.

In future the likely emphasis of management policy will require consideration of enhancement, sustainability, and maintenance of bio-diversity and possibly a selective effort reduction in some fisheries, with promotion of alternative employment especially in coastal areas. Coastal brackish water aquaculture is becoming constrained by environmental and disease concerns (white spot syndrome of shrimp, mangrove removal) while freshwater aquaculture expansion may already find itself in competition for water and land with agriculture (paddy) and irrigation. The fisheries that are currently 'open' may change in the future with increasing commercial interest and resultant limitations in access to the current users of the resources and will require the safe guarding of the livelihoods of aquatic resource users who are poor. In all these contexts, benefit would be gained from increased networking within the region with others.

Research and Communication

Although the formalization of research within the Department of Fisheries in Myanmar only occurred in April 2002, it had already gained considerable experience and knowledge through its monitoring and development functions and through formal and informal research conducted at its fisheries stations. Such as improvements on artificial propagation of the species that are currently cultured and/or stocked in to perennial water bodies. As highlighted by the Minister at the outset of the mission, the increasing importance of aquaculture and continued role of fisheries in the livelihoods and diet of the Myanmar population, as well as an important foreign exchange earner in the future, highlights the need for regular research and extension support to sustain fisheries and aquaculture development in the long term, and also to maintain environmental integrity.

In this regard, the recent establishment of DoF Directorates dedicated to Research and Development and to Aquaculture Extension is extremely timely. This provides a useful administrative framework, to strengthen and systematise a process, firstly to bring together and share the lessons learnt, and thereafter to communicate widely the knowledge gained.

The creation of a Directorate for Research and Development and to Aquaculture Extension has to be followed up, rather quickly, with capacity building in major areas of research thrusts that are pivotal to sustained development of the fisheries sector in Myanmar, and it is suggested that the DoF liaises with the Department of Planning and formulate

a proposal for UNDP support in this regard. It is strongly recommended that the cross-cutting functions of these two new directorates be co-ordinated, strengthened and developed. This could take the form of scheduled semi-annual meetings perhaps hosted by station teams on a round-robin basis.

There is an increasing recognition within Southeast Asia of the benefit of increased communications and of sharing lessons with other fisheries line agencies which face common issues. This would be likely to include not only technologies, but also strategies (including communications) as well as ways of working (incentive structures, monitoring systems).

It is strongly recommended that Myanmar Department of Fisheries increase its formal and informal networking with other line agencies and organizations within Myanmar and also with similar national networks in other countries. It is recommended that Myanmar contact the NACA Secretariat to investigate playing a role in the STREAM Initiative in this regard.

Communications and extension

In common with other extension systems in developing countries around the region, the reach of the extension system for fisheries in Myanmar is constrained by the resources available. As the Myanmar government begins to work more closely with local aquatic resource managers from poor rural communities, increased attention will need to be paid to the use of communication strategies and tools. In particular, the Department of Fisheries will be seeking mechanisms to share information about aquatic resources co-management practices and the livelihoods of people who depend upon the resource.

Poverty, limited education and a lack of access to telecommunications, transport and other communication opportunities all isolate poor rural communities from the rest of civil society in Myanmar. In practice, most rural communities have limited access to general information, and even less to information specific to the management of aquatic resources. Accessing such information can be impossible without the assistance of an external third party. And even if aquatic resource management information is within their midst, pressing and immediate livelihoods needs amongst the poorest can lead them not to take heed.

An initial assessment of communication suggests that:

- Rural communities rely heavily on traditional information sources which will include the Village Chief, Monks and to an extent the Village Elders. Word of mouth and village meetings are still the most popular forms of information dissemination within a village.
- Both radio and television are important sources of information, though they are not considered as accessible as other sources within the village (e.g. Village Chief, etc.). According to DoF estimates, in most villages 50 percent of households have access to a radio and

a television around 5 percent have access to satellite broadcasts. Lack of electricity is commonly not a barrier; with rural electrification often available from local private power sources (e.g. a generator owner who sells connections within a village). In other developing countries in the region an overwhelming majority of villagers prefer to watch television than listen to the radio. Preferences and access have not been surveyed in Myanmar. Broadcasting stations and times are shown in Table 6.

Table 6: Television & radio stations in Myanmar

Channel	Owerahip	Broadcast
Myanmar Radio and TV (MRTV)	Government	07.00-09.00 10.00-15.00 16.00-21.30
Myawady	Army (semi-government)	Mon-Fri 07.00-09.00 16.00-24.00
Yangon City Development Station	Municipal	Sat-Sun 10.00-14.00 11.00-15.00

Possible mechanisms to increase the effectiveness of communications might include investigating some of the following recommendations:

- *Increase the use of mass media, in particular television, radio and any other appropriate communications mechanisms, e.g. travelling theatre/puppetry.*
- *Organize more focused communication activities in villages such as facilitated sessions using posters and flip charts, picture books, etc., farmer field training schools, video sessions broadcast from a mobile broadcasting unit, and pre-recorded information and music broadcast on a village public address system.*
- *Increase the use of village volunteers, study tours, community theatre/role plays, t-shirts, music and song to complement the use of mass media and village-focused communication activities.*
- *Maximise the use of local resources to produce communication materials and involve communities in the development process.*
- *Understand the audience – conduct a base-line knowledge, attitudes, practices survey before developing a communication strategy.*
- *Improve stakeholder networking at the national, provincial and community levels, increase accessibility of existing newsletters, prepare more case study materials, catalogue existing literature in a central resource, and encourage informal networking and cross-sectoral communication.*

The role of Myanmar Fisheries Federation (MFF)

Two important drivers have recently given rise to the creation of a Myanmar Fisheries Federation (MFF). One was the pressure on Myanmar during the period of its accession to ASEAN to increase the representation of civil society in local and national administration. Another is the Yangon Government policy focus on developing a market economy through encouraging private enterprise. In 1998, the Myanmar Fisheries Federation was created from the Myanmar Fishery Association. The organization has national and local coverage; most of the larger (fish) farmers are members of the local MFF branch. A Central Executive Committee (with office holders each having a 3 year tenure) plays a co-ordinating role. The current office holders are drawn more from academia and the private sector. Each local MFF chair is selected by a steering committee every 3 years. A 3-day annual meeting is held in Yangon bringing together 10 local MFF branches whose membership includes Fishery operators, fish farmers and related industries and people. The MFF has a variety of roles in supporting its members:

- In particular MFF is able to support applications made by its members to DoF to undertake fisheries and aquaculture activities.
- MFF can also support applications to the Livestock and Fisheries Bank for loan applications.
- There is some indication that MFF enjoys considerable political favour with the higher levels of government and can negotiate directly for its member's applications.
- Local MFF branches raise issues of collective importance to their members (e.g. from Shan State MFF which

currently has 30 members from the south of the state) such as accessing initial investment, raw materials for feeds, negotiating with local authorities to change use of land.

- MFF helps with negotiation of selling and harvesting, working collectively.
- The national MFF remit includes “transferring technologies to farmers” and “communicating and cooperating with trans-boundary organizations”, although mechanisms for undertaking this do not exist other than through the organization of, and participation in meetings.

In many locations the membership is comprised mainly of wealthy business people who are lessees of leasable fisheries or who own substantial aquaculture operations. There are a number of members with smaller holdings and this is more evident in an area such as Shan State. The membership cost is 300 Kyat/year (or 5 000 Kyat for life) and as such it is probably not the cost of membership that currently limits participation.

The MFF could represent an important vehicle for co-ordination and communication amongst aquaculture producers and fisheries actors both inside and outside of Myanmar.

It is recommended that the communication remit of MFF be expanded and that links be made with other organizations in other parts of the world so that lessons learnt elsewhere may be shared with fisher and farmers in Myanmar and so that Myanmar can share its insights and learning with the rest of the world.



Inle Lake opposite is leased as two fisheries at K60 000 and K40 000. The current lease holder is the Myanmar Fisheries Federation (MFF). The Federation sub-leases to at least 300 fishers raising an income for MFF Shan State of K200 000.

Inland fisheries and aquaculture: conclusions and recommendations

Information and statistics and appropriate valuation of fisheries resources

1. The role of fish and aquatic foods needs to be adequately evaluated, with special attention paid to the distribution aspects and penetration of both fresh and preserved fish into remote areas.
2. The leasable fisheries and open fisheries resource areas vary every year according to the extent of flooding. More effective mapping of these resources would facilitate DoF in estimating the likely production of these fisheries as well as allow better demarcation of individual leases.
3. It is crucial that fisheries related questions are appropriately incorporated into the household survey proposed by UNDP. Care must be taken to identify issues relating to access to fish, and the extent to which fish gathering, collection and purchase are undertaken by households. Asking families if they fish in not sufficient and will almost certainly give a misleading impression of the importance of fish in the livelihoods and diets of the Myanmar people.
4. Department of Livestock and Fisheries could incorporate some simple questions about rice-field fisheries into a proposed agriculture census (because the Department's statistics do not cover rice-fields).

Aquaculture and aquatic resources in rural development

5. It is highly recommended that future poverty focused food security development involving small-scale pond aquaculture be considered also in Myanmar.
6. It is recommended that poverty alleviation objectives of the Department of Fisheries focus on those most vulnerable to hunger, who are likely to be the landless, the urban poor and small-scale producers, each with limited capacity to secure entitlement to food.
7. It is recommended that the capacity of line agency staff to investigate and understand the livelihoods of poor people who manage aquatic resources, and their capacity to use this knowledge in the development of policies, legislation and support services be strengthened. It should be recognized that this is a considerable undertaking.
8. There appears to be considerable scope for further enhancement of leasable and floodplain fisheries through stocking of advanced large sized fingerlings, using appropriate stocking rates and possibly strategic feeding in some of the smaller leases.

9. The Mission is of the view that Myanmar should take steps to re-introduce reservoir fisheries, initially on a small scale, and in conjunction with the irrigation authorities, and over time, supported by research, evolve suitable strategies to optimize yields including the cost-effectiveness of any proposed stocking programme that is to be included, and sustain it in the long term.
10. Rice fish culture can only be tried in a practical situation and the impacts evaluated, ideally with the participation of farmers so that any results are grounded in the realities of their farming systems (i.e. participatory/farmer based research).
11. It is recommended that more nursing of stock for enhancement be undertaken by DoF stations to increase the effectiveness of enhancement programmes.

Institutions, communications and networking

12. It is strongly recommended that the cross-cutting functions of these two new directorates be co-ordinated, strengthened and developed. This could take the form of scheduled semi-annual meetings perhaps hosted by station teams on a round-robin basis.
13. It is strongly recommended that Myanmar Department of Fisheries increase its formal and informal networking with other line agencies and organizations within Myanmar and also with similar national networks in other countries. It is recommended that Myanmar contact the NACA Secretariat to investigate playing a role in the STREAM Initiative in this regard.

The following recommendations relate to communications:

14. Increase the use of mass media, in particular television, radio and any other appropriate communications mechanisms, e.g. travelling theatre/puppetry.
15. Organize more focused communication activities in villages such as facilitated sessions using posters and flip charts, picture books, etc., farmer field training schools, video sessions broadcast from a mobile broadcasting unit, and pre-recorded information and music broadcast on a village public address system.
16. Increase the use of village volunteers, study tours, community theatre/role plays, t-shirts, music and song to complement the use of mass media and village-focused communication activities.
17. Maximise the use of local resources to produce communication materials and involve communities in the development process.
18. Understand the audience – conduct a base-line knowledge, attitudes, and practices survey before developing a communication strategy.

19. Improve stakeholder networking at the national, provincial and community levels, increase accessibility of existing newsletters, prepare more case study materials, catalogue existing literature in a central resource, and encourage informal networking and cross-sectoral communication.
20. Communication remit of MFF be expanded and that links be made with other organizations in other parts of the world so that lessons learnt elsewhere may be shared with fisher and farmers in Myanmar and also share its insights and learning with the rest of the world.

Research

The Mission recognized the following areas as research priorities, and recommends that the DoF, Myanmar liaise with the Australian Centre for International Agricultural Research (ACIAR), and other donor agencies to develop research projects on one more, as an initiative.

21. The Mission is of the view that moderate research inputs in to typical leasable fisheries in a selected region, e.g. Upper Myanmar, will enable to increase the fish production in such fisheries, and consequently have positive influences on improving the lives of the communities and the fish supplies in rural areas. Research on leasable fisheries in non-perennial waters; develop suitable stocking strategies, including species combinations, cost-effectiveness of stocking, and the socio-economics of such fisheries. The project will also address the role of naturally recruiting indigenous species in leasable fisheries. It is expected that such research could lead to enhancing production in leasable fisheries, and also will provide useful information on the biology of important species, and thereby on biodiversity and conservation aspects, and enable to uplift the standard of the “communities” involved in leasable fisheries. It needs to be re-emphasised that although an individual is the lessee, the overall activity is essentially a community activity which provides livelihood to many families, ranging from 40 to whole villages. The Mission is of the view that such a programme would be able to draw from the on-going activities, under the auspices of the ACIAR, in Sri Lanka and Viet Nam on culture-based fisheries, and consequently generate synergies beneficial to all three programmes.
22. Inle Lake in Shan State is an important natural resource to persons, and is important from a biodiversity view point with over 20 animal species being endemic to the Lake. In the recent years the traditional, small-scale “floating gardens” have been expanded significantly through the intervention of commercial growers. The Lake provides the livelihood for at least 800 fisher families and is the main source of animal protein for the inhabitants of Nyaung Shwe township and many of the surrounding townships that purchase the fresh and dried fish produced. The increasing intensity of the surrounding agricultural activities is bound to increase the nutrient and pesticide load in the Lake. The consequences of such increases are difficult, if not impossible, to predict at this stage. It is proposed that a study be conducted on water quality and the fishery of Inle Lake, including the socio-economic status of the fishers. It is expected that such a study will help in bringing about suitable management measures for the fishery, in the light of increasing and possible eutrophication of the water body.
23. In the event the DoF, Myanmar adopts the recommendation to reintroduce reservoir fisheries, it will be imperative that a new management strategy be developed for the fisheries. In order to do so it is suggested that a research programme be undertaken to estimate potential levels of productivity, using suitable yield-predictive models that are already available. The study is also expected to look at the historical data on stocking and returns, and evaluate a rational stocking strategy accordingly. Based on such results, and in conjunction with potential fishers/fishing communities DoF could develop a co-management strategy(s) to ensure the long term sustainability of the fishery resources.
24. The perennial water leasable fisheries tend to use large amounts of artificial feeds, in spite of the high natural productivity of the waters. Fish kills of a minor scale have already occurred in some waters. Detailed studies on the productivity of the water bodies and modelling based thereof could provide useful information on the effectiveness of use of artificial feeds in such large waters, and consequently on the carrying capacities and cost-effectiveness of current practices. It is expected that the research could lead to long-term sustainability of the practices and reducing the cost, thereby reducing the price of fish to the consumer.
25. Biology and artificial propagation and culture of the indigenous river catfish (no firm identification possibly *Selonia*) and other important, potentially culturable indigenous species.

Myanmar – mission report on coastal aquaculture



Myanmar – coastal aquaculture

Coastal aquaculture in Myanmar

Myanmar has a long coastline of nearly 3 000 km. It can be divided into three coastal regions: the Rakhine Coastal Region (from the mouth of the Naaf River to Mawtin Point, about 740 km in length), the Ayeyarwaddy Delta and the Gulf of Moattama (Martaban) Coastal Region (from the Mawtin Point to the Gulf of Moattama, about 460 km in length) and the Thanintharyi Coastal Region (from the Gulf of Moattama to the mouth of the Pakchan River, about 1 200 km in length) in the Bay of Bengal and in the Andaman Sea.

The Department of Fisheries (DoF) reports that fisheries are the fourth most important source of exports earnings, valued at US\$ 218 in 2001. Marine capture fisheries are reported in official DoF statistics as 932 090 tonnes, freshwater fisheries as 235 530 tonnes, and aquaculture 115 870 tonnes. Of the total aquaculture production, an estimated 18 794 tonnes comes from coastal aquaculture. Shrimp farming in particular has grown significantly in the past 10 years and small amounts of marine fish (groupers) and crabs are also produced. Several thousand tonnes of crabs are “fattened” for export, but not included in the above coastal aquaculture statistics.

Coastal habitats and resources

With a coastline of nearly 3 000 km, several large estuarine, delta systems and numerous offshore islands, Myanmar possesses a considerable diversity of coastal habitats, including coral reefs, mangroves, sandy beaches and mudflats. The north-central part of the country is dominated by the vast delta of the Ayeyarwaddy River, one of the largest rivers in Southeast Asia.

Mangrove forests

Several major rivers, including the Ganges in the north and Ayeyarwaddy, Sittaung and Salween in the Gulf of Martaban have created soft shores where mangroves develop extensively. Myanmar has a long coastline and adding to this the coastline of over 800 islands in Thanintharyi division alone there is an extensive coastal zone for colonization by mangroves. The key question here is the value of these mangrove systems and particularly their contribution to fisheries and the livelihoods of people living in the coastal zone. Too often, in accounting the global area of mangrove forests, Myanmar has not been included in tabulated figures. The integrative significance of Myanmar mangrove forests to regional ecosystem functions is therefore difficult to determine.

Myanmar has the fourth largest expanse of mangrove areas in Southeast Asia after Malaysia, Bangladesh and Papua New Guinea (see Table 1). Myanmar mangrove forests are dominantly in the Ayeyarwaddy, Thanintharyi and Rakhine state/divisions. Shrimp aquaculture is also dominant in these areas.

Mangroves in Myanmar appear to be classified as “Primary” and “Secondary” status. Primary mangrove areas are protected under jurisdiction of the Ministry of Forestry and not available for aquaculture and are essentially forest reserve. Significant jurisdiction of secondary mangroves seems to be devolved to the Department of Fisheries for availability to conversion for aquaculture. The delineation of Primary and Secondary status does not appear to be well publicized nor the criteria to define these geo-ecological zones. The function and services that these secondary mangroves provide to the Myanmar coastal zone is difficult to evaluate due to lack of available research. Some parallels can be drawn from knowledge generated on other mangrove regions of the Asia-Pacific to give some qualitative evaluation of their significance for Myanmar and highlight critical questions that may need to be answered. These issues are discussed later in this report.

Coral reefs

The chain of islands between the Ayeyarwaddy delta and the Andaman Islands contains coral reefs, but (like mangroves) they have been only minimally surveyed. Along the southern coast is a complex of forested offshore islands known as the Mergui Archipelago, where the majority of Myanmar’s coral reefs are found. The Mergui reefs are thought to be similar in structure and diversity to the reefs around the offshore islands of Thailand. Currently, 65 coral species in 31 genera have been cataloged in Myanmar’s reefs, but these figures are probably an underestimate. Lack of surveys and scientific information impedes a true evaluation of the wealth of Myanmar’s reefs. The RRSEA project estimates that Myanmar has 1 700 km² of coral reefs.

According to the Reefs at Risk analysis, 56 percent of Myanmar’s reefs are threatened. The RRSEA model suggests that overfishing is the primary threat to nearly one half of Myanmar’s reefs. Destructive fishing, coastal development,

Table 1: Southeast Asia Mangrove Forest Areas

Country	Area of Mangroves (ha)
Malaysia	652 219
Bangladesh	417 013
Papua New Guinea	411 600
Myanmar	382 023
India	356 500
Thailand	287 000
Viet Nam	286 400
Pakistan	249 489
Philippines	246 699
Indonesia	216 271
Sri Lanka	4 000

Source: UNDP/FAO (MYA/90/003): Report on Mangrove Forest Products and Utilization of the Ayeyarwaddy Delta.

and sedimentation are considered each to threaten an estimated 10 percent of Myanmar's reefs. Marine-based pollution impacts only three percent of reefs (WRI, 2002).

Mudflats, other resources systems

The long coastline contains a diversity of other marine resources systems. A detailed analysis of these resources was not possible with the information available. Up-to-date assessments of coastal resource systems are urgently needed, as the basis not only for planning of sustainable aquaculture, but for the protection and management of the countries key ecological resources.

Brief history and status of coastal aquaculture

Coastal aquaculture to date is mainly focused on shrimp farming. Freshwater fish culture started in the 1950s, but shrimp farming only started in the mid-1970s. Traditional shrimp farms of about 10 000 acres (3 620 ha) have been in operation since 1978 along the banks of Naaf River in Rakhine State, bordering with Bangladesh. People in the northern Rakhine States started with "trap and hold" farming practices in areas with large inter tidal zones with abundant shrimp juveniles. Such extensive shrimp farming practices, producing 100 kg shrimp/ha/year still dominate the shrimp culture sector, due to investment constraints, although intensive practices are gradually being adopted in some coastal areas.

There were some initial attempts to introduce more "scientific" shrimp culture in 1984-85 with loans from the Asian Development Bank. Technicians were trained abroad, and two shrimp hatcheries and three brackishwater shrimp farm projects established. Although shrimp hatchery production as successful to some extent, there was limited further development of shrimp farming until the mid-1990s. Only in the past 2-3 years has private and government investment being used to start operating some of these facilities again.

In 1995, the Ministry of Livestock and Fisheries encouraged the development of shrimp farming and private investments in intensive and semi-intensive shrimp farming gradually emerged after the promulgation of the Aquaculture Law. FAO also provided support through a TCP project for the development of shrimp farming in the late 1990's, including assistance for small-scale shrimp hatchery development. In addition to private aquaculture farms, some small-scale farms

have been initiated by UN agencies, notably in the Ayeyarwaddy delta. In 2000, a state level committee was established and a three-year plan initiated to encourage shrimp farming. This has led to favourable conditions for investment and significant growth in the past 3 years.

According to DoF figures, cultured shrimp production in 2002 was approximately 18 800 tonnes that has increased significantly from last year production of over 6 000 MT. In 1999-2000 budget year, 12 381 tonnes of shrimp were exported that earned approximately US\$ 70 million while freshwater giant prawn produced over 900 tonnes and was exported for over US\$ 7 million. These values could be total export volume combined with shrimp from capture fisheries, as the cultured shrimp production for the said year was only 4 021 tonnes. Live fish export from marine cage culture was started in 1996-97 budget year with nearly 4 tonnes worth approximately US\$ 8 000 from a private company in Myeik Province. The company has expanded its cage culture capacity and by 2000-01 its export volume reached over 20 tonnes. There are two other companies operating marine cage culture in Myanmar. Although mud crab culture is expanding, its production and export volume was not available. Some existing information are provided in Table 2.

Sub-sector analysis

Shrimp farming

The current total shrimp farming area in 2002 is estimated as 193 265 acres (over 70,000 ha) of which over 85 percent (around 60 000 ha) is under extensive culture techniques. An estimated 5 180 acres is under more intensive culture and another 22 768 acres under improved extensive (extensive plus). Under the government's shrimp culture expansion three-year plan from 2000-2002, traditional shrimp farms were being upgraded to improved extensive culture system. *Penaeus monodon* is the main species produced, but other species of wild shrimp are collected from extensive, and traditional "trap and hold" ponds. Recently, the exotic *Penaeus vannamei* has been introduced to at least one shrimp farm, on a trial basis. Issues and risks surrounding this exotic introduction are discussed below.

The largest area of shrimp farming is found in Rakhine State (155 533 acres), followed by Ayeyarwaddy (33 373 acres), Yangon (7 394 acres), with smaller areas in Bago, Kayin, Mon and Thanintharyi.

Table 2: Aquaculture production (from DoF and Win Lat, 2003)

Budget year	F/W Leasable Fisheries (tonnes)	Total Cultured Area (ha)*	Production (tonnes)				
			F/W Fish	F/W Prawn	Marine Shrimp	Oyster Shell	S/W Pearl (Moggi)
1994-95	64 800	33 675	69 120	1 120	1 460	3 100	24.0
1995-96	60 800	38 464	68 320	1 760	9 720	3 971	28.6
1996-97	60 750	40 482	78 880	2 080	n.a	6 653	21.8
1997-98	64 377	40 666	85 280	4 160	4 174	6 653	21.8

The shrimp area and production has increased substantially over the past three years under the special government programme, and particularly extensive traditional systems. In March 2000, the total shrimp farming area was 67 445 acres (24 440 ha). Although the farming area has increased drastically, Winn Latt (2003) reported that shrimp production actually declined to 6 554 tonnes in 2000-2001 budget year. Decreases in production might have been due to scarcity of wild shrimp seed and disease problems in semi-intensive and intensive farms. The shrimp production increased nearly two fold in 2001-2002 budget year, perhaps a combination of increases in area and yields.

The team visited the shrimp farming zone in Yangon where intensive shrimp farming is practiced. The area is “Shrimp culture zone Number 1” at Kyauk Tan. The farms are developed on a specially designated area, on supra-tidal land (previously paddy, and coconut), covering 1 090 acres. There are 11 companies. The farms were started in 2002, without sufficient seed, and therefore were allowed to import shrimp post-larvae, leading to disease problems. All 11 farms were affected by white spot disease. The culture period is from January-May and from June-October. Water management involves a reservoir, and water treatment, according to DoF regulations. If white spot occurs, farms are not allowed to discharge, but have to treat ponds with chlorine (200 ppm) for 5-7 days before water can be released.

Recent private sector investment has come from Thailand, Indonesia, and Taiwan. A large Indonesian investment is in the planning stage on an island in the southern part of the country. Some private sector investment has been used to rehabilitate shrimp hatcheries and farms developed under an ADB loan (suspended in 1988), and some new farms. Technical assistance has also been provided with such investments; however, based on the teams visits, awareness of basic pond and health management practices among the farmers is fairly limited and further education and awareness building is required.

In another part of Yangon division, a project has been initiated by the DoF to support local farmers. Households have been provided with up to 50 acres of land along the sea-shore under another specially zoned area (Shrimp farm zone number 2). DoF support includes: shrimp culture training; soil and water quality testing; and assistance in obtaining loans from the Livestock and Fishery Development Bank (10 000-50 000 Kyats/acre). DoF reports that 4-5 households working together operate some of the farms. The project,

which started in 2001, may provide an interesting case study in local peoples participation in shrimp farm development.

Traditional extensive ponds tend to be very large and commonly exceeding 50 ha, although some extensive farms operated by poor farmers in Rakhine may be as small as 0.4 ha (UNHCR report). More intensive farms have smaller ponds, around 1-2 ha, similar in size to that of other countries. The very low yields, around 100 kg/ha/yr, from extensive farming systems remain a concern. Given the large area concerned, even a modest increase in pond yields could make a significant difference to total production.

Although *P. monodon* is the main species of interest, extensive farms produce other types of shrimp, and fish for home consumption. According to a report from UNHCR in 2000, ponds in Muangdaw in Rakhine produce three types of shrimps from shrimp farms: tiger prawn (*Penaeus monodon*), white shrimp (most probably *P. indicus*) and some small shrimps. The amount and species of other shrimp varies from area to area. Apart from shrimp, brackish water fish species may be caught for home consumption, an advantage of the extensive systems.

Land use and shrimp farming in secondary mangroves

Shrimp culture viewed during the mission was confined to areas within Yangon, Rakhine and Thanintharyi State/ Divisions. In Rakhine, shrimp farms have been developed on various inter-tidal lands, including what is reported as secondary mangrove. Mangroves are classified into primary and secondary mangroves, with secondary mangroves being available for aquaculture. It was unclear to the mission as to the criteria for such classification and to what extent “total ecosystem” functions have been considered.

The team made a visit to a typical extensive shrimp farm in Taunggok township, Rakhine State, among secondary mangroves. The farm has been operating for 4 years. A single surrounding dyke was constructed around the whole secondary forested farm area and filled on high tide. The only digging was a subsurface canal adjacent to the dyke, due to soil removal for dyke construction. All mangroves were initially left standing and appear to have died due to bunding, with forest timber decomposing. There is an intention to later remove mangrove stumps and upright dead trees. Subsurface soils in this region are believed to be acid-sulphate with pH 3.5 to 4. Natural recruitment of larvae and natural feed

Table 3: Changes in area and estimated shrimp production estimated under the “Three-Year Plan” (modified from DoF data, and Win Lat, 2003)

Planned Year	Cultured Area (ha) by culture system					Actual shrimp production (tonnes)
	Extensive	Extensive Improved	Semi-intensive	Intensive	Total Cultured Area	
Initial Year (99-00)	27 022	n.a	196	77	27 296	6 621
Year 1 (00-01)	n.a	n.a	n.a	n.a	41 233	6 560
Year 2 (01-02)	39 230	7 972	1 313	n.a	48 515	18 750

na: data not available; includes 74.3 ha (44 tonnes) of freshwater prawn culture under extensive improved and semi-intensive category.

are standard practices in such systems. Stocking density is estimated as approximately 1-2/m². There is no manual input of feed or stocking. Shrimp are harvested twice monthly after first two-months of grow-out, thereafter harvested twice-monthly netting 25-30 kg per harvest. Mud crabs were also collected from the ponds. The three timber sluice gates need to be replaced annually and although concrete gates are preferred, investment costs are considered prohibitive.

The secondary mangrove area visited was available for other aquaculture ventures. The land acquisition process was reported to be by formal application to local DoF authorities. The applicant needed to supply referees and the application was reported to be open to public comment. According to the farm owner there has been stable production for almost 4 years although lately there has been a noticeable decline. He attributes this decline to fall in recruitment due to increasing number of shrimp farms in the area. Sluice gates are opened at high tide but not neap tides. The pond is rarely drained totally and at most during a singular tidal cycle only. During discussion with farmers they requested information on improved farming technology.

Shrimp farm management is by hired workers, often a family team. The visited farm had six adult workers. The farm owner lived in Taunggok town and employed a farm manager and workers living on-site. These farm workers were paid a net salary of 12 000-15 000 Kyats/month with food and lodging. Farm workers can harvest other aquatic products (mainly mud crabs) and retain proceeds. Workers receive a “good crop” bonus with payment coinciding with the New Year. The farmer pays 200 Kyats/acre tax to DoF annually and the lease arrangement is such that he is able to sell this farm at his own wish. There is no direct assistance from Government in the acquisition or development of his farm, however Government is providing technical assistance to upgrade the farm from extensive to extensive-plus. The extensive-plus model would involve building dykes to partition the 140-acre farm into 2-2.5 acre ponds with flow channels.

The mission also visited an area in Taunggok where DoF is planning a demonstration/experiment on the upgrading or improved-extensive systems, through subdivision of the ponds, diversification of part of the farm to mud crab, and improving productivity in smaller ponds. The site represents an interesting opportunity to look at improved and mixed farming systems in mangrove areas.

Shrimp hatcheries and shrimp seed supply

Shrimp seed for stocking of ponds come from the wild and from hatchery-reared post-larvae. Fry collection from the wild is particularly common in Rakhine State, where there are widespread “trap and hold” traditional farming systems relying on wild seed (stocked, or naturally entering ponds). There are probably several thousand people, including poor landless coastal people, who participate in catching of these wild shrimp fry. DoF has recently taken steps to ban collection of wild fry.

The second source of fry is hatchery-reared post-larvae (PLs), and the number of hatcheries has been increasing since 1997.

Currently, there are around 31 shrimp (and prawn) hatcheries that have a capacity to produce around 650 million PLs. However, DoF reports that in 2002 demand was not sufficient, and that the only around 300 million PLs were produced. The demand from grow-out shrimp farming is also seasonal. DoF estimate a total demand of 600 million PL/year. Some hatcheries produce nauplii that are then transported elsewhere for nursing to post-larvae.

Some hatcheries produce both freshwater prawn and marine shrimp alternately with changing salinity. The government is keen to promote further hatchery development. However, due to reports of inconsistent spawner availability and timing of farming, seed production is either over supply or in shortage. As a result, shrimp PL were sometimes released into natural waters. There are government owned hatcheries, but some have been sold or leased out to the private sector, or are carried out as joint venture operation with private companies (DoF, 1999). Costs of hatchery operation are reported by DoF to be quite high, due to high cost of inputs (e.g. *Artemia*).

Problems have emerged in the balance between supply and demand. For example, shrimp farm grow out ponds were developed quite fast at Kyauk Tan, without sufficient seeds. Therefore, farmers were given permission to import post-larvae. The inevitable result was that Myanmar introduced the white spot syndrome virus (WSSV), and serious outbreaks of shrimp disease were encountered. All 11 farms in the Kyauk Tan area were reported to the team as being affected by white spot, and the disease now seems to be spreading around the country. Introducing effective import procedures and hatchery and farm health management practices are essential to support the sustainable development of the shrimp industry. Recommendations on this issue are provided later in this report.

The mission visited hatcheries near Yangon, and in Rakhine state. In one hatchery near Thandwe, problems of bacterial disease had affected the production in 2002 (necrosis and *Vibrio* problems reported). This farm was also using crab to feed mature animals, a practice that may lead to WSSV infection of brood stock. Spawner mortality was also reported as a problem. The visits clearly indicate a number of areas for improvement of hatchery management practices and disease control measures.



Shrimp hatchery under construction in Rakhine State.



Penaeus monodon brood stock collected in Rakhine State.

Brood stock supply

Shrimp brood stock appear relatively abundant in Myanmar, and indeed the Andaman Sea as a whole is an important source of brood stock for neighbouring countries. Shrimp brood stock can be exported under licence from the Department of Fisheries. Gravid females are sold at about 4 000 Kyats, a price that is relatively cheap compared to other countries in the region (commonly US\$ 100 or more). From Thandwe, hatchery operators reported a six hour boat journey to collect brood stock. There is a close season during August-September when marine fishing, including shrimp brood stock collection, is not allowed. One hatchery in Thandwe reported that 40 percent of brood stock collected were WSSV positive, an alarming figure, if correct. Further investigations should be carried out.

Feeds and feed supply

A major issue in the shrimp farming sector is feed supply. Local made commercial feeds are becoming available, but some intensive farms still import feed from abroad. Fish meal plants have been established in the past 3-4 years to take advantage of the good local supply of fish meal. There are now five local feed mills for fish and shrimp/prawn, with one factory producing 15 tonnes/day of pelleted feed. Win Lat (2003) reports the need to improve quality and quantity of

shrimp feed. Imported feeds also have various disadvantages, such as difficulties in importing via border trade and quality problems due to long transport and import procedures. There is no import of fish meal, as Myanmar has good fish meal resources. The technology for fish and shrimp feed production comes from China and Taiwan.

Land use and availability

The traditional shrimp farms that still dominate Myanmar are developed on inter-tidal land, including mangrove areas. In the Yangon division, some intensive farms have been developed on supra-tidal, low yielding, agricultural land. The team visited Yunadi shrimp farm (Kyauk Tan) where there are 11 companies involved with shrimp farming. The land in this area, previously agricultural land, has been designated as a shrimp culture zone. However, reports suggest difficulties in obtaining permission from the Department of Agriculture for establishing further zones on agriculture land.

A different type of project had been started in another part of Kyauk Tan, outside Yangon. Coastal areas are allocated to individual families, with 50 acres per family. Services are being provided by the DoF, including shrimp culture training, soil and water tests, and availability of loans from the Livestock and Fishery Development Bank (Kyats 10 000-50 000/acre). DoF officials say that there may be 4-5 households per farming area and report to the team that 50 families were involved. The project had started in 2001 as an experiment to involve local people in shrimp farming. Unfortunately, some farms had experienced white spot disease problems. It would be interesting to undertake a more detailed analysis of the project, and its potential for replication elsewhere in coastal areas of Myanmar.

Aquatic animal disease control and health management

Shrimp disease problems have recently emerged, already causing serious economic impacts to shrimp farms in Myanmar, including semi-intensive and extensive farms, and it appears that shrimp brood stock may be infected to varying degrees. The effects on wild populations are unknown. White spot disease (WSD) was first reported in 1999 or 2000, and apparently related to the introduction of post-larvae from abroad (reports suggested PLs were imported due to local



Semi-intensive shrimp ponds in Rakhine State.

shortages, without any risk reduction measures). The disease has spread throughout the country, affecting both intensive and extensive farms.

DoF is taking actions to address the problem. These include some disease monitoring, development of PCR testing facilities, and looking at other possible causes of shrimp disease problems, such as environmental change. The current situation though, if not brought under control through urgent action, represents a serious threat to the sustainability of shrimp farm investments, Myanmar's ability to attract foreign investment, and future trade status. Shrimp health management strategies are required urgently at national and farm levels, involving government and private sector.

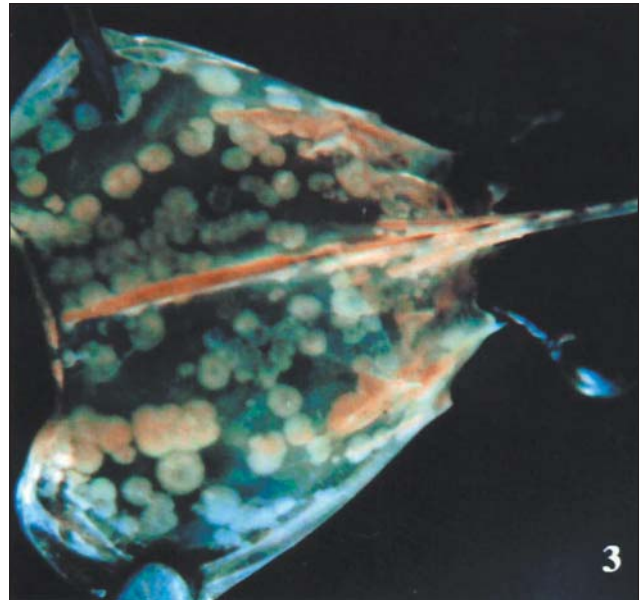
The policy towards import and movement of live aquatic animals deserves special attention. Already Myanmar has lost a major comparative advantage (white spot disease status) due to ill-advised imports, and one report suggests Myanmar has faced trade problems of white spot in consignment of prawn/shrimp exported to one market. Future controls are essential, and should be agreed to and monitored by both government and private sector. Regarding other species, Myanmar's groupers and native seabass may be relatively unaffected (e.g. from VNN, iridovirus), and again introductions should be avoided (e.g. if grouper fry catches should decline), or if necessary only under strict quarantine conditions following regional protocols (FAO/NACA, 2000).

Myanmar was a participant in the development of the Asian Regional Technical Guidelines on Health Management and Responsible Movement of Live Aquatic Animals (FAO/NACA, 2000). The development of a national strategy for implementation of the guidelines in Myanmar is essential to protect the aquaculture industry and future trade status. The current ban on imports of shrimp PLs is a good decision by the government, since there are no risk assessment measures in place for imports, and no facility for testing the quality of the import PL. This capacity should be developed as part of the national strategy implementation.

White spot syndrome virus (WSSV)

White spot syndrome virus (WSSV) causes white spot disease (WSD) of shrimp is a major current problem in shrimp culture, and the mission has identified major risks and actions that can be taken in Myanmar. Experience from other countries in Asia shows that various practical management strategies can be adopted to reduce risks of white spot disease outbreaks. The major management actions recommended by the mission can be summarized as follows:

- *PCR and diagnostic capacity.* One PCR testing centre is under construction in Thaketa Government Hatchery in Yangon. This testing centre will provide a PL testing service for WSSV to support farmers in the Yangon area. Ideally, testing facilities should be established in major brood stock sourcing areas, with priority to Thandwe. A shrimp brood stock screening scheme will substantially reduce the chance of PL contamination. One more PCR testing centre is required in the southern area (for example in Myeik). Laboratories should be supported by



*Classic clinical signs of white spot disease in *Penaeus monodon*.*

development of standard protocols, training, and laboratory procedures.

- *Brood stock testing centre.* Since there are only around 20 hatcheries producing PL at the moment, it should be relatively simple to introduce effective health management measures to significantly reduce risk of WSSV virus spreading with infected post-larvae. It was estimated that, based on the PL requirement (600 million/year), a maximum of 4 000 brood stock are required over one year. If all the brood stock are tested as WSSV free before release to the hatcheries, the chance of contamination will be greatly reduced. A government-private brood stock testing centre should be established with the support from private hatcheries since in practice, private hatcheries will have to test the brood stock before using by themselves. There are two main landing ports for the brooder, in Thandwe and one on the southern coast, therefore two testing centres are probably required.
- *Strengthen government and private extension programme.* Similar to the other Asian countries, the government lacks experienced extension staff to provide basic training in shrimp health management to support local farmers. The information received by the farmer is mainly from neighbours, private sale persons or technicians. The government should try to engage the private sector since they normally have better access to farmers than the government staff. At the same time, the government can arrange training/workshops for farmers with some financial support from private sector. A concerted effort and collaboration between the government and private sector should be initiated as a matter of urgency to ensure that farm staff are properly trained, and equipped with the know-how to identify/manage disease problems.
- *Prepare a Code of Practice.* The government is encouraged to develop a health management "Code of Practice" to be agreed between government and private

sector. This should include an agreed programme of brood stock testing, chemical and drug use testing and registration, imports of aquatic animals. Adherence to this Code of Practice that will protect aquaculture investments in the country, could be a condition of investment in the shrimp farming business in Myanmar.

The mission considers that existing experiences from NACA, FAO and ACIAR support for shrimp health management in the Asian region should be engaged to support development of a shrimp health management strategy. An outline of recommended white spot “risk management” measures are given in the adjacent box. Although the management measures are relatively straight forward, implementation will require a substantial extension effort, backed up by suitable trained staff and laboratory facilities.

Farm registration and zoning

The establishment of zones for shrimp culture as the team saw in Yangon division is a positive step that allows coordinated actions to be taken to disease control and environmental management. Ideally, such schemes should follow regulations developed by the government in order to reduce the risks of disease spreading from the different farming areas. Zoning principles should also be applied to separate major hatchery zones away from major intensive farming zones, further helping to reduce risks.

Regarding the current ban on import of *Penaeus vannamei*, most of the farmers interviewed during the mission misunderstand this white shrimp. They believe that the shrimp are stronger and more tolerant to extreme conditions than black tiger. *P. vannamei* is thought to be free from any disease. Therefore, it should be easier to culture. But the reality is that many white shrimp available in Asia are not really pathogen free (SPF) stock and some may be contaminated with exotic viruses (e.g. Taura syndrome virus). If farmers import contaminated PL and stock in different places, this will be a major route to contaminate the wild population and finally leading to a serious outbreak. The government should not allow importing any white shrimp into the country at this stage. As Myanmar will likely continue to receive requests from the private sector for imports, further advice should become available from an assessment of *Penaeus vannamei* imports to Asia, being planned by FAO/NACA in 2003.

Drugs and chemicals

As most shrimp farming is traditional or extensive, shrimp farmers use few chemicals or drugs. Indeed, the shrimp produced from such systems should be very good quality, “organic” type. The team noted however, that some hatcheries and more intensive farms were using a range of chemicals to control shrimp disease. These chemicals were not always in clearly labelled containers (none in Myanmar language), and in one case a banned compound was noted in a hatchery, a chemical that may lead to residue problems for shrimp imported to EU and other countries. The team considers that further attention is needed to restrict use of chemicals, perhaps by developing regulations that control the

“Risk management” points and strategies for white spot disease of shrimp, based on experiences within Southeast Asia (from AAHRI, NACA and ACIAR)

Minimise risk of pathogens entering ponds with infected shrimp post-larvae:

- Screening throughout the hatchery cycle, from brood stock to post-larvae
- Maintaining separate stocks during hatching/nursing
- Good hatchery management
- Screening of post-larvae prior to stocking
- PL nursing on extensive farms

Minimise risk of pathogens entering ponds during grow-out:

- Good pond preparation practices
- Screening of inflow water

Use best practice crop planning and pond management to maintain health bottom soil and water quality:

- Good pond preparation
- Seasonal stocking practices
- Reduced water exchange, water reservoirs on intensive farms
- Efficient feeding practices

Regular monitoring of crop health and environmental conditions.

Intervene to control adverse conditions or emergency harvests.

import and use of chemicals in shrimp aquaculture in Myanmar. Further awareness should be created among private sector investors of the need to avoid use of banned chemicals. Labels for use should also be prepared in Myanmar language. This could be done in cooperation with some of the major importing companies that are increasingly active in the coastal areas of Myanmar.

Further information on banned drugs can be obtained from FAO and NACA.

Shrimp markets

Shrimp and prawns are making an increasingly significant contribution to the export earnings of Myanmar. Major markets for “prawns” (DoF statistics do not differentiate between freshwater prawns and brackishwater shrimp) are China (4 073 tonnes, but lower value), Singapore (2 604 tonnes), Japan (2 992 tonnes), and United States (1 775 tonnes). EU also imports prawns from Myanmar, with UK as the leading importer at 921 tonnes. The total value of “prawn” exports is US\$ 104 million for 2000-2001 as reported in the Fisheries Statistics of Myanmar, out of a total of US\$ 218 million.

The high demand and price of shrimp and prawn abroad have attracted local and foreign investors in fishery product trading. Meanwhile, shrimp and prawn production from capture fisheries has declined, and aquaculture is becoming a more important source of supply. Market channels exist for high value shrimp, involving middlemen, brokering and raw material collecting systems. The export market for high value aquatic products remains high and consequently shrimp receives a high policy priority.

Myanmar has faced some marketing problems, including when the EU imposed trade restriction over products from Myanmar in 1998. This caused seafood trading companies to suffer losses and shrimp and prawn exports to the EU were restricted. The team did not look in detail at quality control systems, but noted that the Department of Fisheries has made investments in a good laboratory at Thaketa, with facilities for residues and quality analysis. The private sector has also invested in laboratories for quality control, as seen by the team in Myeik. Such quality control mechanisms are essential to maintain access to markets.

Increasingly, importing/consuming countries are paying attention to the production system, particularly food safety concerns associated with use of chemicals and microbial contamination at pond level. Such issues will need more attention in future.

Crab farming

Mud crab farming is also important in Myanmar. Mud crab (*Scylla serrata*, and related species) culture in mangroves or tidal flats is practiced mainly in the Ayeyarwaddy delta area, in Rakhine and southern parts of Myanmar. The farming practice can be ecologically friendly because it does not replace mangrove and uses locally available low cost materials. Most farming is practiced in ponds (fattening crab), bamboo enclosures or cages located in river and canal systems. Culture densities for ponds and cages in Rakhine are reported as two to four juveniles/m² (weighting 25 to 40 g/piece) and 10 to 25 kg/m² respectively. Chopped trash fish, *Acetes* and agricultural by-products are used for feeding crab. After six to seven months, marketable crabs (200-250 g/piece) are harvested by handpicking during low tide. Win Lat (2003) reported a survival rate of 40 to 60 percent, and yields may be 275 to 600 kg/ha/crop. Mud crab may also be harvested along with shrimp in traditional or extensive shrimp ponds. One farmer interviewed by the Mission in Tangatt Township was fattening mud crabs successfully in a 1.5 acre pen.

Trade in mud crab (*Scylla spp.*) appears to be thriving in the Ayeyarwaddy delta region. A large part of the production is for export to Singapore and China, including significant quantities transported to China by road. Since crabs must arrive live at their final destination, the trading network is well organized.

The coastal team visited the Doung Koo Maw crab culture farm in Myeik. This is the only farm in Myanmar, producing soft-shelled crab. The farm collects mangrove crabs from local areas; the owner when interviewed suggested that crabs come from within a five kilometer radius. The farm started

in 2000 with 209 acres of ponds, although only 8.25 acres are used for crab culture. Local fishermen harvest the mud crabs from the wild over 4-5 days during the full moon period. A small trap is used for catching crabs, in mangrove areas, and other local waterways. The prices reportedly vary with size; smaller sizes are 15 pieces/kg (1 200 Kyats/kg), or 10 pieces/kg (slightly larger size). There are reported to be 500 collectors involved. Each fisherman can catch up to 40 kg (maximum) in the full moon period. The farm prefers to obtain small size also. The technology is based on crab farming in Ranong (Thailand), and the owner of the Ranong farm is a shareholder in the Myeik farm.

After capture, the mud crabs are put in individual containers then after 4-5 days they will moult (some may take longer up to 60 days). 100-150 g size crabs are sold with a market price of 4.4 US\$/kg. The owner says that the crabs lose 30 percent weight (however, looking at the crabs this seems unlikely) with a 90 percent survival of crabs. The farm is trying some experiments to look at whether cutting swimmetes will accelerate moulting. However, this technique increases mortality to 30 percent. So far, the farm has produced 40 tonnes of soft shelled crab. Feed is small fish and 60 tonnes have been used so far. The price of trash fish is 40-60 Kyats/kg (80 Kyats/kg maximum, and 30 Kyats/kg minimum). Fish is cut into small pieces by women (see image below) (fish heads and guts are removed and sent to a fish meal plant) and the fish body is fed to crabs.

Crabs are kept individually in containers held on rafts. The containers are checked every three hours, and molted crabs removed. Molted crabs are put in freshwater as they will harden if kept in brackishwater (after 3 hours). They may



Scenes from a mud crab fattening farm near Myeik.



spend 1-2 days in freshwater before being sent to factory for freezing.

Crabs are frozen and then marketed through Penang. The final destination is Japan as well as Malaysia. The owner/manager said there were market limitations, and was seeking to diversify markets (there is an interesting research question here of whether market is a constraint). Supply of wild crabs was not seen as a constraint.

The farm employs 150 workers, of which 90 percent are women. Women are involved in cutting fish, cleaning baskets, feeding and checking crabs.

Marine and brackishwater fish culture (groupers and seabass)

Groupers, *Epinephelus* sp., popularly known as “Kyauk Nga” or “Nga Tauk Tu” in Myanmar language, are important marine fishes belonging to the Family Serranidae. Groupers are exported live, and in chilled/frozen forms, from Myanmar. The export of live groupers is intended primarily for the live reef fish trade, to Hong Kong.

Marine and brackishwater fish farming is found in Ayeyarwaddy delta area, Rakhine and southern parts of Myanmar. There is some extensive pond culture of seabass (*Lates calcarifer*) in these areas, and seabass are also collected from extensive shrimp ponds. DoF reports some import of seabass fry from Thailand, and export of seabass to Australia. Again, as stressed above, care is essential when importing fish to ensure no health problems.

Groupers are cultured in Myanmar using fry and juveniles caught from the wild. There is no marine fish hatchery. Fish farmers grow them in net cages and ponds. Presently, floating net cage culture of groupers is conducted in the coastal areas at the southern and western part of Myanmar (Myeik Archipelago and Gwa township). Grouper seeds for culturing are obtained from the wild.

There are around twenty species of groupers in Myanmar waters, but so far only four species have been cultured commercially. The main species are orange spotted grouper (*E. coioides*), greasy grouper (*E. tauvina*), black spotted grouper (*E. malabaricus*) (Myanmar name Goung Lone Anet Pyauk) and *E. bleekeri* duskytail grouper (Myanmar name Bather Pyauk).

The team visited a cage farm in Myeik where small numbers of giant grouper (*E. lanceolatus*) and *E. fuscoguttatus*, mouse grouper (*Cromileptis altivelis*) and some ornamental fish were also present. The mangrove red snapper (*Lutjanus argentimaculatus*) was also being cultured. Small numbers of Emperor red snapper (*Lutjanus sebae*) and *Cephalopholis* species (probably *C. argus*) were also noted on the cages. The list of grouper as reported from Myanmar waters from a recent APEC paper is given in the adjacent box above (Tin Win, 2002).

Grouper fry are collected using various devices including rock mounds, brush piles, brush lures, and fish traps.

The grouper farm visited was operated by the Pyi Phyto Tun international company. The project was approved in 1995 and implementation started in 1996. Technical assistance was provided by technicians from Hong Kong. Total investment was reported as 65 million Kyats. The farm is at Mawtonegyi in Kyunsu Township. The project started at 150 cages, now there are 270 cages, with size of 3 m x 3 m, and depth 1.5 m. The site is close to an island, that provides shelter and freshwater. The water depth is 6.5 m at lowest tide. The farm does not move cages around, although some fish cages were moved following a mortality/disease problem that was experienced. The bottom in the area is sandy, suggesting reasonable water movement to disperse cage wastes.

The farm stocks both fingerlings and larger fish. The farm reports catching around 3 000 fish every 15 days, peaking around the full moon day. Fish are caught by hook and lines

Anyperodon leucogrammicus
Cephalopholis argus
Cephalopholis boenak
Cromileptes altivelis
Epinephelus analogus
Epinephelus areolatus
Epinephelus bleekeri
Epinephelus coioides
Epinephelus fasciatus
Epinephelus fuscoguttatus
Epinephelus labriiformis
Epinephelus maculatus
Epinephelus malabaricus
Epinephelus megachir
Epinephelus merra
Epinephelus sexfasciatus
Epinephelus tauvina
Epinephelus undulosus
Plectropomus areolatus
Plectropomus maculatus

(feathered hooks) and to a lesser extent traps. The fish are purchased directly from fishers, or from middle men/agents. Prices are set on size (not species), at 100 Kyats/piece (6-10 inches), and 700 Kyats (above 11 inches, weighing more than 300 g). The farm reports that local catches are declining, and fish are now collected from further away. Fish come from 30-50 km away, and some as much as 70 km away. The most recent area is Yeantoung town, about 70 km away from the farm. Six agents/middlemen are reported to be involved, with a total of 700-800 fishermen selling wild caught fish. The farm reported no regulations on the size of fish that can be caught for stocking in cages; however, DoF regulations stipulate that only fish over 300 g size may be harvested. The mission received no reports of cyanide fishing in Myeik, but received a report from Rakhine. The close season for catching fingerlings is from July-September.

The fish are fed daily in the morning, with an estimated 3 tonnes of trash fish needed for around 400 000 grouper. The trash fish come from the company trawlers. There has



Grouper cage culture near Myeik.

been at least one fish mortality (cages were moved, and this was reported to have solved the problem). Fish are treated using formalin, and freshwater to treat parasites. There is a piped supply for freshwater from the nearby island to use for treatments.

The fish sale price is reported to be set on size (not species): 5 US\$/kg for fish above 1 kg; 3 US\$/kg for fish less than 1 kg. Fish are exported in a live fish transport boat to Hong Kong. Export is carried out 4/5 times/year, with 5-6 metric tonnes/time. The price is around 6 500 US\$/tonne, depending on size. The transport boat is reported to be less concerned about species. The boat was reported to visit at least one other site (a nearby coral island – where there are 100 cages) to collect fish.

The farm employs 32 workers. The salary is around 10 000 Kyats/month, to 50 000 Kyats/month.

There are reported to be two other grouper farms in the division – one of 100 cages, plus one other (no information). The major issues arising from the mission include the need for assessment of state of wild caught resource and development of techniques for sustainable harvest. Such information to support sustainable management of the wild grouper resource is urgently needed. In the future, sustaining a grouper industry will need hatchery development, and attention to development of feeds. Myanmar, because of the ready availability of “trash” fish and fish meal, would be in a good position for development of a marine fish industry based on locally made feeds.

Marine fish hatcheries and fish seed supply

The DoF has a further marine fish hatchery in Thandwe, where work is being started on seabass (*Lates calcarifer*) breeding, and the plan is then to graduate to grouper after experience is gained. One of the keys to successful breeding is a healthy brood stock, that can take many years to collect and mature. The importance of early collecting of grouper brood stock for such hatchery projects is emphasized.

The DoF recognizes the potential for future development of mariculture in the southern part of Myanmar. The main initiative for mariculture development in this area within DoF is the plan to establish a marine aquaculture station at Kyun Su Township in Thanintharyi division, starting in 2003 (a budget of 30 million Kyats has been allocated). The DoF plan to start work with seabass culture, but eventually will extend the work to include groupers. One aquaculturist has been assigned to the project. There are opportunities for external assistance in training of staff, and design of the facility.

Other species

The mission was informed of several other coastal aquaculture activities. Oyster aquaculture was tried in Rakhine during the 1990’s, but not successful. Cockles have been harvested from natural beds, but no management applied (apart from licensing). A cockle farm/bed in southern Myanmar had imported seed from Thailand, but was now using local seed from Myanmar. Gracilaria culture (seaweed),

involving two species) was attempted in 1980's in Rakhine state, but apparently not successful.

The mission visited a lobster holding facility in Myeik (The Golden Star Ice Factory, Pyi Phyo Tun International Company) where lobsters are held prior to export. The lobsters are purchased from fishermen and then exported to Hong Kong. They are reported to be exported live via Yangon. Three species are involved – *Panulirus versicolor* (buy at 12 US\$/kg, sell at 30 US\$ 30/kg), *P. longipes* (2 species, no prices provided), and *P. ornatus* (buy at 40 US\$/kg, sell at 80 US\$ 80/kg). Lobsters are reported to be captured by hand and trap. There are three other similar operations in Myeik. Squilla, some groupers, and a moray eel were also noted in the tanks. Two separate water management/tank systems were used to separate systems. The holding facility exported US\$ 1.305 million of exports in 1999. The DoF regulations provide a 100 g limit on size of lobster captured. There is no farming of lobster in Myanmar, but this could be a potentially important opportunity for further investigation (provided sustainable management measures for collection of juveniles could be ensured).

There are also pearl farms in Myanmar. In Bokeyyin, there are four pearl farms (a Japanese and Malaysian investment). The species are *Pinctada maxima* (gold lip pearl) and *P. margaritifera* (black lip pearl). The administration of pearl farming is with the Ministry of Mining, not the Department of Fisheries.

Role of coastal aquaculture in people's livelihoods in Myanmar

The general picture that emerges from the mission and review of secondary information is of a coastal population that includes significant numbers of poor and vulnerable people and a high proportion of people dependant on fisheries activities and aquatic products for income and nutritional security. The current status of coastal aquaculture is quite limited, but already the livelihoods of perhaps several thousand people are directly and indirectly involved in the sector. More people are involved indirectly (e.g. collection of shrimp post-larvae, and collection of crabs and grouper fry, women involved in preparation of feed for mud crab fattening) that directly in production. Even so, numbers are probably quite small compared to the inland sector.



Wild-caught lobster at holding facility in Myeik, ready for export.

The mission's visits to Rakhine and Thanintharyi provide an initial overview of the situation, but further assessments would provide better understanding of the livelihoods of people in coastal communities and a better basis for interventions to support responsible development of coastal aquaculture.

Rakhine State has the lowest average household expenditure (<0.5 US\$/day/household) in Myanmar, way below international poverty line and one of the poorest in Myanmar, with some extremely poor people subject to special assistance programmes (e.g. UNHCR). The coastal population relies heavily on fishing and aquatic products for income and food. In northern Rakhine, coastal households are involved in shrimp fry collection and are directly involved in shrimp aquaculture, and to a limited extent mud crabs and grouper cage farming.

Thanintharyi Division in southern Myanmar includes the Myeik archipelago with over 800 islands. The division has a higher average household expenditure (0.6 US\$/day/household), but still considerably below the international poverty line. The population in the Division relies heavily on fishing (80 percent reported to be involved in some way). Aquaculture has potential to be a significant source of income and employment for people living in this division.

The mission was unable to evaluate to what extent poorer members of the coastal community have benefited from coastal aquaculture, although opportunities may be substantial to support local development through sustainable aquaculture. Information is required (e.g. through livelihood analysis) in Rakhine and Thanintharyi regions to understand livelihoods to gauge opportunities for support for aquaculture. Such information is not available from existing sources, but may perhaps be obtained by the upcoming census, or through special assessment.

Some limited experience in small-scale coastal aquaculture exists within the UN-HDI supported project in the Ayeyarwaddy Division (Bogalay, Laputta and Mawlamyine Gyun). Small-scale aquaculture trials were started with fish cage culture, shrimp culture, mud-crab pen culture and oyster culture. According to the project reports, fish cage culture faced problem with debris carried down by the tidal waves clogging the cages. Moreover the cost of materials used in the construction of cages were expensive for small holders. Prawn culture with cages constructed using bamboo has been successful with potential for expansion, and a few landless people have adopted it. Mud crab pen culture was considered to have potential for expansion on a commercial scale in the near future. Oyster culture trials did not produce any conclusive results. The UNDP project considered that crab fattening in particular was a suitable poverty alleviation activity, as it requires only a small plot of land, yielding favourable income in just two-weeks. A number of aquaculture activities initiated by the project in the villages were replicated in the adjoining villages, as well as in the adjoining non-project townships, due to their lucrative nature.

The UNDP project also provides an indication of the important role that small-scale fishery activities play for poor, landless, people in the Ayeyarwaddy delta, suggesting that

an integrated approach to development, considering aquaculture and fishery activities, within the context of a rural development approach may be successful for poverty reduction, rather than purely sectoral or sub-sectoral driven initiatives. A further project involving aquaculture was implemented in Rakhine, under an UNHCR programme, although outcomes were not available to the mission.

Gender

Women are involved in coastal aquaculture and participate in production and providing inputs. Win Lat (2003) reports women's involvement in pond construction or embankment repairs. Women and children gather wild shrimp seeds from tidal creeks for rearing in traditional ponds in Rakhine State, and are involved in post-harvest activities on other coastal aquaculture farms. The most impressive involvement of women in aquaculture seen by the mission was in the mud crab fattening farm in Myeik. Here, women were involved in various ways in tending crabs and preparing crab feed.

Role of small-holder aquaculture?

Investment in coastal aquaculture is presently focused on export commodities. From the mission's brief overview, it appears to be mainly richer individuals/companies who are directly involved, with shrimp as the main item, and smaller amounts of crab and grouper. Investment by larger companies/individuals has proved important in developing infrastructure for aquaculture, for example, private sector investment support to shrimp hatcheries, and employment, such as several hundred people involved in Myeik (women in soft-shell crab farm) and input supplies (mud crab, trash fish, and grouper fry supply to cage farms in Thanintharyi Division).

The mission considers the opportunities for participation of local small-holders in coastal aquaculture should be further explored and supported, where appropriate. Regarding the potential for small-scale poverty-focused mariculture, there are major questions of technology, extension support, capital

access and security that remain unanswered. If non-technical constraints can be addressed, technology for several species might offer opportunities to support small-scale aquaculture in coastal areas, which if conducted correctly will contribute to foreign exchange earnings as well as coastal development. The mission recommends an assessment be undertaken to evaluate opportunities, including gathering of experience from recent UN-sponsored aquaculture projects initiated as part of poverty reduction projects.

The grass roots participation in shrimp farming is reported by Winn Latt (2003) to be mainly limited to hired labour. The large farms that are common are a significant barrier to entry and should be reduced by farm size and ensuring security of land tenure. The DoF should consider further industry development programme of small farms available to local grass-roots community, perhaps based on experiences in "Shrimp farming zone number 2", where special attention is reported to have been given to the local community. Aquaculture development could consider the agriculture demography model (see Table 4). While absolute agriculture farm size may not be feasible for aquaculture it nevertheless displays a relative demography, which may facilitate some entry into the industry by the poor. It is essential that there is security of land tenure and skill transfer so that micro-credit schemes will feel secure in their investment.

Income diversification

Currently, established traditional/extensive shrimp farms seem to focus mostly on mono-culture of shrimp. Diversifying the income base will help reduce risk. In mangrove forests, diversifying into mangrove forest related income opportunities such as low cost/low technology crab culture could be explored. It is unlikely at this stage that silviculture will be attractive to farmers, given the vast timber reserves of Myanmar and the prohibition of charcoal production since 1993. To suggest silviculture mangrove forestry for charcoal production may be risky in that it could require significant resources to regulate due to potential encroachment on natural forests.

Table 4: Agriculture trends in size of family/society land holding

Farm Size Acres	1974-75		1985-86		1995-96	
	Peasant Families and Societies (%)	Farming Area (%)	Peasant Families and Societies (%)	Farming Area (%)	Peasant Families and Societies (%)	Farming Area (%)
<5	62.6	25.9	61.6	25.1	61.1	26.6
5 to <10	24.1	31.9	25.0	31.1	25.1	32.3
10 to <20	10.8	28.0	11.4	28.3	11.0	27.4
20 to <50	2.6	13.1	2.4	12.4	2.2	11.0
50 to <100	0.04	0.5	0.04	0.53	0.04	0.50
≥100	0.01	0.72	0.02	2.5	0.02	2.2
Total Area	23.5 M acres		24.2 M acres		24.8 M acres	

(Source: RPH, 1978; Mya Than, 1988; RFESC, 1998.)



Extensive, traditional, shrimp pond in Rakhine State.

Resources management and environmental issues

The Department of Fisheries (1999) emphasises resource sustainability and environmental issues in the strategy for national agriculture development within the Livestock and Fisheries Sector. Environmental issues need to be carefully considered in the development of coastal aquaculture in Myanmar; paying close attention to environmental management of the sector will not only provide a sound basis for sustainable development, but will also ensure continued market access into importing markets that are becoming increasingly sensitive to environmental concerns.

As coastal aquaculture is still relatively undeveloped, compared to other countries in the region, there are good opportunities to learn from others, and adopt more effective environmental management practices. The following discusses some of the resource management and environmental issues arising during the mission.

Coastal mangrove forests

There is some development of shrimp farming in mangrove areas. This, in part, appears to be driven by the government policy not convert agriculture land to aquaculture. In coastal areas, this leaves so-called “unused” land for aquaculture, in Rakhine state at least secondary mangroves are classified in this category, meaning shrimp farms can be developed in secondary mangroves.

Biota in mangrove habitats has been harvested for many centuries – fish and shrimp being common products. The preservation of mangroves has for many years been argued on the basis of their function as nektonic habitats among their many other valuable roles. Mangroves harbour higher densities of juvenile fishes than other adjacent habitats evident from studies in the Indo-west Pacific and elsewhere. This suggests that mangroves are a source of food shelter and protection. Studies of prawns and fish indicate an important role as nursery grounds and refuge from predators. Many of these coastal species spend critical early stages of their lives in mangrove waters. There are several patterns of diversity in mangrove species and habituating organisms in communities.

- More species are found in large rather than small mangrove estuaries.
- Mangrove fish communities in the Indo-west Pacific are species rich compared to Atlantic regions.
- Sub-tropical estuaries house fewer species than tropical estuaries.
- Connectivity between mangroves and adjacent ecosystems influence diversity.
- Nature of offshore environment is critical in determining movements of larvae and juveniles.

According to a recent JICA report (2000) there are 29 species of mangroves in Myanmar hosting 69 species of fish, 13 species of shrimp, 4 species of crab and 9 species of other

shellfish. However, information on mangroves in Myanmar is sparse.

Disturbance and alteration of mangrove habitats tend to lead to departure of fish populations and other nekton and they do not readily return to the impacted zone. Recovery depends on duration, geographical extent and nature of impact. Habitat loss therefore results in low population densities and loss of diversity of mangrove habituating organisms. In a planned geographic disturbance by human intervention such as aquaculture and urban development it raises the question of interference into population connectivity among (micro) habitats. In a larger mangrove ecosystem framework some areas of mangroves and waterways may be critical in facilitating migration patterns between microhabitats to the upper/lower estuary and offshore. The selectivity of which secondary mangrove areas to convert for aquaculture must consider these factors, to ensure regional sustainability of fisheries production and ecosystem services. The risk here is that the opportunity cost of conversion could be greater than the returns from aquaculture. At minimum, selectivity of which tracts of secondary mangrove forests should be removed must be based on ecological research to ensure that returns from aquaculture are far greater than the opportunity cost of services that targeted mangroves provide.

Mangroves occur in a variety of climates from arid to cool temperate and equatorial regions. They also occur in a variety of soil types from clays, silts, sands, coral line rubble and peat. Salinity can range from close to 0 to 90. It would be illogical to presume that there would be a uniform productivity at regional or subregional level. The current contribution of mangroves to fisheries is not adequately quantifiable for Myanmar due to lack of research. Foundational data needs to be researched to sample habitats for their relationships to fisheries production. While some generic models have been suggested none appear to have sufficient robustness to quantifiably value mangrove systems generically for fisheries production. The drawbacks of these models are evident by the need to support them by hypothesis rather than empirical data.

Mangrove plant biomass in a fisheries context can be viewed as that which is accumulated and that which is released from forest structure. Accumulated biomass (above and below ground) establishes the physical forest structure. The non-accumulated portion is shed by trees and can include litterfall, algae, root loss, root leachates and herbivore grazing. These losses and their movement via tidal outwellings and/or incorporation into other biogeochemical processes can form an essential dimension of inshore or offshore habitat sustainment. If forest detrital supply is reduced then there could be interference to coastal food chains (habitats) reliant on that supply.

Nutrient uptake from land runoff by mangroves suggests that they can be effective pollutant sinks as they are efficient nitrogen and phosphorus accumulators. These nutrients can be incorporated for biomass production or stored within the plant for later use. Mangroves have significant capacity to absorb dissolved nutrients and other elemental species. If the

plant has no immediate physiological use for these nutrients they can be stored in the root systems. Furthermore the complex root systems of mangroves can be very effective at trapping sediments from land runoff sources. If conditions are appropriate, mangroves can colonize sediments and stabilize them to modify the foreshore and reduce re-suspension thus ensuring some protection for near shore habitats. Mangroves can provide very effective protection against potentially erosive wave-action, which is a substantial consideration in areas such as Rakhine State, which is prone to cyclonic events. Rakhine State also has a near coastal range (Rakhaing Yoma). Episodic heavy rainfall events can result in rapid land runoff where mangroves can play an important role in trapping sediments before this runoff water body reaches the open sea.

There are a number of issues for consideration with the traditional or improved extensive shrimp farm models in mangrove areas. These include displacement of secondary mangroves; in-pond mangrove forest decomposition; farm size, tenure and equitable entry to the industry; and lack of farm income diversification/security.

The choice of which secondary mangroves are selected for conversion to aquaculture does not appear to be based on any valuation of ecosystem services provided by these forests. It is not known what type of (micro) habitat is being removed by bunding forests or which ecosystem processes are being interfered. While it may be difficult to quantitatively value secondary mangroves, some attempts should be made to qualitatively value based on fundamental research into their role and function. The decision as to which tracts of secondary mangroves are made available for aquaculture development can then be based on minimum opportunity cost for longer-term sustainability.

In the extensive model, mangroves are not clear felled prior to filling ponds with water after dyke construction. Once bunded, tree respiration is interfered resulting in tree death. The gradual in-pond forest decomposition can adversely affect water chemistry and pond quality. Initially litter leaching of organic matter occurs (particularly tannins) followed by bacterial and fungal community assisted decomposition. Wood components also decay through chemical and biologically assisted processes. Teredid molluscs have been found to be an important agent in mangrove wood decomposition. Root systems also begin to decompose with decomposition rates being dependent on species and root diameter. These induced forest decomposition processes can impact on pond quality and affect sediment-water interface processes. The breakdown of this introduced organic matter could elevate oxygen demand. Enhanced bacterial populations can amplify amplitudes of dissolved oxygen content due to increased respiration rates imbalanced to photosynthetic production. This can render low net primary production leading to critical oxygen levels inducing stress to shrimp. The impact of decaying mangrove matter specifically in-pond has not been studied. It may be beneficial to clear fell forest before pond construction to alleviate organic matter loading and its potential adverse affects.

Farm size in regions visited was generally large-scale farms owned by more wealthy individuals/companies or foreign investors. It was notable that there appears to be a stark absence of community level aquaculture. Farms of 20-30 acres are common in other developing countries (e.g. Mekong delta of Viet Nam) owned by local people as the basis of their livelihood. The grass roots participation in Myanmar appears to be more limited, although some models are being tried. These large farms are a significant barrier to entry and should be reduced by farm size and ensuring security of land tenure. Government should consider an industry development programme of small farms available to local grassroots community. Some prerequisites are essential such as training in farm operations/management, disease management, market analysts, transport systems and optimal mangrove buffering capacity to ensure basal natural recruitment to be sustainable. The demography of aquaculture farms appears to be slanted to the wealthy.

Future options

The mangrove forestry aspect of shrimp aquaculture development in the visited states/divisions needs careful analysis with further research. Ecosystem services provided by secondary mangroves are not yet understood in these environments. As the basis of this problem is the absence of a research unit within the Department of Fisheries. This has obviously been limited due to insufficient funding – Ministry of Livestock and Fisheries receives less than 2 percent of national budget yet contributes 8-10 percent to GDP. The role of a research division should be to generate knowledge for decision makers and policy formulation for sustainable industry development. Some research foci must include:

- Role of ecosystem services provided by secondary mangroves to ultimately lead to the development of a “Management Plan for Secondary Mangroves” on a State/Division basis.
- Mangrove taxonomy in secondary mangroves to ensure retention of diversity and guidance to reforestation if required.
- Soil mapping in secondary mangroves to determine which soil types are most suitable for aquaculture.
- Impact of in-pond mangrove forest decomposition on shrimp productivity. The potential use of harvesting this in-pond forest for timber could also be investigated.
- Suitable buffer zones between shrimp farms based on capacity to provide larvae for natural recruitment to farms and ecosystem services such as litter-fall/detritus, coastal protection, water flow dynamics, nekton refuge, etc.

These research areas need to be complimented with economic analysis for industry development at the grass-roots and commercial level. That analysis must include training in farm management, markets analysis, transport systems to markets and hatchery services.

Regarding the development of crab aquaculture in secondary mangrove environments, the farm visited in Myeik appears

to be a very efficient operation and sets a model for replication at commercial and community levels. There remains a question of sustainability. Juvenile crab recruitment extends beyond the 290-acre farm limit and there is no control over where fishermen trap supply. Currently it's estimated that juvenile crabs are sourced in a 3-5 km radius from the farm site over the past 6 months of operation. Inevitably juvenile crabs will need to be sourced further a field to sustain supply. This removal of natural populations begs the question of sustainability and mangrove forest floor ecology.

It is recommended that such farming operations should include a crab hatchery and that harvesting of natural populations should only be permitted to supplement supply. In any case harvesting from surrounding areas will need to be regulated. It is impossible to gauge the effects of this practise without ecological research of the role of these juvenile crabs in mangrove ecology processes. The establishment of a hatchery will also display a commitment for long-term investment rather than short-term investment. Its absence would facilitate a rapid exit.

The crab farming model also has the potential to be adapted at community grass roots level development, as shown by experiences in the Ayeyarwaddy Delta. Consideration should be given to smaller farms operated by local community farmers. If this technology can be adapted to smaller scale farms – community level crab culture could be attractive to the international donor community. This may also enhance technology transfer for integration to larger scale farms. If small-scale crab culture were to be supported by harvesting natural populations it would be essential to determine populations and productivity among secondary mangrove forests to ensure these farms are sufficiently buffered with mangroves to support sustainable recruitment.

There are also plans to establish large-scale foreign invested shrimp farms in this region with private investment from France and Indonesia. The size of these farms range from 200 to 40 000 acres. The impact of this scale on forest removal is unknown and should be evaluated.

Present farming systems developed in mangrove areas have extremely low shrimp productivity, in some cases probably less than the fishery values of original mangrove resource (commonly 100-150 kg/ha of fisheries products from other regional countries, but values need to be verified for Myanmar). Upgrading and rehabilitation of low productivity of coastal ponds requires attention to increase value of the resource.

Coral reef resource systems

Corals are an important coastal resource for sustaining coastal fisheries, particularly in the southern part of Myanmar. Information on coral reefs in Myanmar is limited compared to other countries in Southeast Asia, but estimates made by WRI (2002) suggest Myanmar has 1 686 km² of coral reef area, around 1.7 percent of the Asia-Pacific total (see figure in adjacent box). An analysis of information on the status of the reefs suggests that the condition of coral reefs in

Myanmar is relatively good compared to some other countries in Southeast Asia (WRI, 2002). Even so, the estimates suggest that 56 percent of Myanmar’s reefs are at “medium” or “higher” risk from over fishing, or destructive fishing and anthropogenic factors (e.g. global warming) (WRI, 2002).

The mission was unable to gather first hand data on the importance of coral reefs to coastal communities in Myanmar, but coral reefs are vital to the livelihoods of millions worldwide and particularly within the Southeast Asian region. In some areas, for instance the coastal regions of major archipelagos including Indonesia and the Philippines, as well as Small Pacific Island States, this dependence is extremely high (Burke, Selig and Spalding, 2002; Whittingham, Campbell and Townsley, 2002). Reefs are known to act as a ‘key-stone resource’ i.e. one ensuring that people just manage to escape poverty. Described as ‘interstitial poor’, in that they are often overlooked in coastal development projects, many groups do not have the resources to undertake alternative development options, (Whittingham, Campbell and Townsley, 2002) and are extremely vulnerable to any decline in reef condition. Further information on the coastal communities in Myanmar, and their relations to coral reefs, are needed.

The recent development of aquaculture of groupers is dependent to some extent on collection of seed from coral reef areas. Live fish traders visiting Myanmar are also collecting fishes that are closely related to coral reefs, for trading into the live coral reef fish trade in Hong Kong and China. The value of this trade is difficult to assess, but appears to have increased over the past five years. Care needs to be taken to ensure that non-destructive fishing methods are used for this trade. To sustain grouper aquaculture in the country, it will also be necessary to move towards hatchery establishment.

Some management initiatives been taken in coral reef areas. There are reported to be three marine protected areas (MPAs)

- The government of Myanmar is many years behind its neighbours in recognizing and meeting the need to identify and preserve natural resources. Technical and financial assistance from experienced countries for institutional strengthening and capacity building of the Myanmar government are needed.
- Major surveys are required to determine where various ecosystems are found and what their status is. Surveys should focus on little known areas, especially the Mergui Archipelago, to determine conservation potential.
- In the university system in Myanmar, many well-trained scientists have retired. There is a great need for training of local scientists to survey and monitor coral reefs and other marine environments.
- Organize training course and study tour for MPA planners and managers to neighbouring countries with established MPAs.



in Myanmar. The management status is given as “unknown” in the WRI reefs at risk analysis and covers only 2 percent of reefs. This suggests the need for more extensive management of the resource. DoF has responsibility for management of one of these areas, in Lanpi Island in the Thanintharyi Division. The management is under the Township DoF officer in Boke Pyine (8 hours by boat from Myeik), who makes occasional visits. The marine protected area is mainly planned to be managed for tourism. DoF is institutionally responsible, however, apparently has limited capacity and awareness on coral or MPA management.

Further information on the status of coral reef resources, people dependent on them, fishing practices, and conservation status, should be obtained, as the basis for suitable management measures of this important resource. It is recommended to build awareness and capacity within DoF for marine protected area management. Cooperation with some regional initiatives is also encouraged. Myanmar was included in a recent analysis of MPAs in Southeast Asia and the recommended actions are reported in the box on the left (derived from WRI, 2002). These recommendations may also be considered.

Other environmental management issues for aquaculture

DoF is making progress in environmental management of more intensive shrimp farms, and is encouraging the private sector through zoning and water treatment protocols. The team visited a designated shrimp culture zone at Kyauk Tan. The infrastructure of the zone includes a water supply and drainage system that allows for separate intake and discharge. Water reservoirs are also used for treatment of incoming water, and effluent ponds for discharge. The adoption of such environmental management measures in more intensive shrimp farming systems is welcome. Such initiatives should



Cromileptes altivelis – a high value grouper species from a marine cage farm near Myeik.

continue to be upgraded to support effective environmental management guidelines and support to the private sector.

In the law relating to aquaculture enacted in 1989, there are several articles that control the impact of aquaculture on the environment. For example, changing the waterway and hydrology of the farming area in natural waters is prohibited. Also a DoF directive exists that stipulates aquaculture farm effluent should contain BOD of less than 10 ppm and a sedimentation pond should be used if the farm is more than 15 acres in area. Freshwater shrimp farming is not encouraged by a regulation that does not allow presence of saline water in freshwater areas.

However, regulatory measures on importation of exotic species and exportation of live fish and shrimp need to be strengthened, a situation that risks the sustainability of aquaculture sector. There is also a need to strengthen government regulations to control drugs and chemicals use in aquaculture sector as mentioned above.

Government policies, plans and institutions

The Government is giving high priority to coastal aquaculture development. A high level special development committee for shrimp culture was established for development of shrimp farming in 2000-2003.

The Law Relating to Aquaculture was enacted in 1989 to promote aquaculture in a sustainable manner. The creation of the law has already produced positive outcomes, leading to increased aquaculture farming area and production. The law gives clear responsibility to the Department of Fisheries for development of inland and coastal aquaculture. The stated functions of DoF are:

- Demarcation, allocation and administration of land and water for aquaculture.
- Granting leases and issuing licences for aquaculture.
- Monitoring and inspecting aquaculture enterprises.

- Taking legal action against any person who contravenes the law.

The Myanmar Foreign Investment Law, also provides incentives for investment in aquaculture. As export income from coastal aquaculture has been increasing, the government interest and support for the sector has also been growing.

The enactment of the Myanmar Fisheries Law in 1990 prohibits the use of destructive fishing gears, amongst other regulations for management of the capture fishery.

Institutions

The Department of Fisheries (DoF) of the Ministry of Livestock and Fisheries is the major government institute responsible for management of coastal aquaculture development. The DoF has an officer in every coastal township, although the DoF officers are mainly responsible for licensing and policing of licenses. A diagram of institutional set up of the DoF is provided in the inland team's report.

With regard to coastal aquaculture, the Department of Fisheries is presently mainly focused on licensing, and quality assurance through Yangon (quality assurance in the two areas visited by the mission, is mainly done by private sector, or through sending samples to Yangon. Testing facilities are under development in Myeik).

The mission considers that there is a need to build the capacity for extension and delivery of services to the private sector and coastal poor engaged in aquaculture/fishers.

The DoF also has responsibility for research, however, this function needs to be substantially strengthened if it is to address the key researchable issues relevant to coastal aquaculture development in the country.

The Ministry of Agriculture is not directly involved in coastal aquaculture, but its policies have major influence on the fisheries sector, particularly the conversion of wetlands to rice paddy (and associated loss of fisheries habitat), and restrictions on use of agriculture land for fisheries and aquaculture, and multiple use of reservoirs for fisheries.

The Ministry of Science and Technology is reported to support some aquaculture research however no further information was provided to the mission.

The Ministry of Forestry is responsible for management of forests, including mangrove forests. It appears though that the management of 'secondary' forests for aquaculture has been ceded to the Department of Fisheries. The Ministry of Forestry also has some responsibility for management of protected areas.

The University of Yangon and Maw-la-myaing (Moulmein) provide teaching and research in coastal aquaculture. These universities offer few aquaculture related courses in the curriculum of the Department of Zoology of Yangon University and Department of Marine Science of the University of Maw-la-myaing. Recently, universities have

redrawn their curriculum in line with needs for the country's development programme, including aquaculture. However, there is reported to be a shortage of human resources and basic facilities for aquaculture related education and research. Win Lat (2003) reports that aquaculture related programmes at the universities are not linked closely with private or government organizations with limited practical training.

Research

The issues for development of the coastal aquaculture industry can only be addressed via research to provide knowledge for decision makers and policy development, and to help solve problems faced by farmers. An understanding of processes and ecosystem functions and services can help aquaculture develop in a sustainable manner.

The building of capacity for research within the Department of Fisheries would be a significant step in addressing these issues. Re-investment into the fisheries industry from its contribution to GDP could support sustainable growth and may provide a basis for improving livelihoods through lower barriers to entry by grass-roots level farmers.

Mangroves are an integral dimension of the coastal zone function and protection. While some may have to be converted for aquaculture industry development, it is important to ensure that those mangrove systems that are most critical to the coastal zone are retained.

The role of secondary mangroves to fisheries and to the wider coastal zone needs to be investigated for the range of services offered. These include their role as nektonic habitats, land runoff entrapment, coastline protection, tidal flow dynamics and habitat connectivity. A number of other researchable issues arise from the mission and are discussed elsewhere in this report.

Education and training

A cornerstone for sustainable coastal aquaculture is the development of well-trained people. Education and training is therefore essential to support the sectors growth.

DoF has taken some initiatives in this regard, with a special course in shrimp culture in 2001. The DoF stations organize 3-month courses in freshwater fish culture at fisheries stations. However, these efforts need to be significantly strengthened and coordinated. For example, the mission noted only one trained aquaculturist (completing a Masters degree at the Yangon University) in the whole Thanintharyi Division, an area with major development potential and investment focus by foreign companies.

Education and training is therefore an important issue that needs to be addressed in the short and long-term. A structured approach involving DoF and Universities (e.g. Yangon, Maw-la-myaing) would be preferable. There are opportunities to further engage the private sector more actively in supporting training courses (such as the 2001

shrimp course conducted by DoF). Donor assistance might also be provided in designing, developing course materials, training of trainers and teaching.

Non-government agencies/donors

There is a small but increasing involvement of international NGO's in supporting rural development in Myanmar, and some are showing an interest in fisheries and aquaculture for poverty alleviation. The Myanmar Fisheries Federation, part of the ASEAN Fisheries Federation, is also supporting aquaculture development in Myanmar, although appears to be mostly focused on inland areas.

The Human Development Initiative Programme (HDI-3rd Phase) of UNDP, governed by the legislative mandates laid down by UNDP Governing Council (1993) and decisions of the Executive Board (1996 and 1998) have supported some projects that have incorporated coastal aquaculture as part of income generating and poverty reduction initiatives. These include:

- UNDP/FAO project Environmentally Sustainable Food Security and Micro-income Opportunities in the Ayeyarwaddy (Delta)-MYA/99/008 (recently completed).
- UNHCR funded FAO project titled Support for Agriculture and Natural Resources Development (GCP/MYA/001/HCR).

Given the fact the aquaculture sector is expanding rapidly, and with staff constraints within the DoF probably continuing for some time, it is likely that the NGO sector can and should play an important role in the future development of coastal aquaculture within the country.

Land use planning and coastal management

One of the critical issues for sustainable coastal aquaculture development is land use policy, and to have planning processes in place that allow balanced use of land for aquaculture, and other uses in coastal areas.

The precursor of aquaculture zoning is seen in the Law Relating to Aquaculture (1989) where Section 11 provides the right of the Department of Fisheries to define land for aquaculture.

The land use policy in coastal areas is directed towards agriculture development. There appears to be a lack of flexibility in using agriculture land for aquaculture. This may be focusing shrimp farm development towards less suitable mangrove areas, when more suitable sites may be available on sub-optimal agriculture land.

According to interviews with farmers in Rakhine, farmers obtain permission from the village government, then the request will be referred to the township and district level, and possibly state/division, and central government for approval. There appeared to be no overall plan for coastal aquaculture development in coastal areas that clearly identifies suitable areas and zones.

Although these issues were not explored in detail during the mission, government should consider the adoption of an integrated coastal management planning approach. As there is limited experience on this approach in Myanmar, some pilot studies could be initiated first, in one or two locations, and then gradually expanded depending on experience.

Without effective management of coastal resources, the considerable social and economic value of Myanmar's habitats, including mangroves, and coral reefs, will be significantly reduced. Balancing the immediate needs of coastal communities, the desire for long-term sustainable resource use, and the maintenance of natural ecosystem processes is a significant issue in most coastal areas. Together, these goals should form the guiding principles for coastal management.

Business investment in coastal aquaculture

The Myanmar government welcomes foreign investment in the aquaculture sector, and several large investments are on-going or planned for aquaculture in the coastal divisions. There are a number of institutions involved in the approval of foreign investments in the aquaculture and fishery sector. Further details are provided in a FAO report (www.fao.org/docrep/field/382903.htm) (Support to Special Plan for Prawn and Shrimp Farming, Myanmar, TCP/MYA/4554).

Market trends and implications

The current markets for coastal aquaculture products are almost solely export. Products are exported to a wide range of countries, as frozen product (shrimp, soft-shelled crabs) or in live form (mud crabs, groupers and lobsters). The sector already contributes significant foreign exchange.

There are a number of market trends that have implications for coastal aquaculture, particularly shrimp (chemicals, trace-ability, development of market chains), and live marine fish (standards are currently being developed for import of live fish to Hong Kong by APEC). These regional and global trends will influence the future development of aquaculture in Myanmar.

Chemicals and residues in aquaculture products deserve particular attention. Myanmar's coastal environment offers opportunities for a "clean, green" image for aquaculture products. Image and markets may be damaged by chemical/health problems, and in some markets may be influenced even by use of mangroves for shrimp farming. There has been some commendable work on quality assurance, and there is a need to continue to develop quality assurance/clean quality product through working closely with responsible private sector. Promoting the development and adoption of codes of conduct and "better management practices" (BMP) schemes with the private sector would provide a basis for a set of informal "rules" that might help guide investment and management of the export-oriented sector.

The market incentives for sustainable management of aquaculture and fisheries products globally are becoming

more significant. These trends will influence Myanmar, particularly increasingly attention to certification and traceability.

Coastal aquaculture: conclusions and recommendations

Coastal aquaculture in Myanmar is mainly limited to shrimp farming, with smaller quantities of mud crabs and groupers produced. The sector contributes significant export earnings, and shows potential for future development and diversification. Extensive brackishwaters, tidal estuaries and clean marine environments exist along a long coastline of nearly 3 000 km, with potential for coastal aquaculture development. Most coastal aquaculture in Myanmar is practiced with traditional methods, but intensification of shrimp farming in particular is gathering pace. Because of low urbanization and industrialization in coastal areas, water pollution caused by chemical and industrial waste is negligible, providing opportunities for production of high quality product. However, degradation of habitats, such as coastal mangroves, and coral reefs, is a concern. Government policy is supportive to expansion of coastal aquaculture, but careful attention is required to its sustainability, to maximize creation of opportunities for employment, income generation and improved livelihoods of people living in Myanmar's coastal areas.

Coastal communities

The general picture that emerges from the mission, and review of secondary information, is of a coastal population that includes significant numbers of poor and vulnerable people and a high proportion of people dependant on fisheries activities and aquatic products for income and nutritional security. Coastal aquaculture development is presently quite limited, but already the livelihoods of perhaps several thousand people are directly and indirectly involved in the sector.

There appear though to be significant barriers to entry of poor people into coastal aquaculture. These barriers seem to include land access, skill acquisition, access to credit and support services, scarce availability of small land holdings, lack of micro-credit systems and security of land tenures.

1. Opportunities may be substantial to support local development through sustainable coastal aquaculture initiatives. Information is required (e.g. through livelihood analysis in Rakhine and Thanintharyi regions) to better understand livelihoods and gauge opportunities for participation in aquaculture. Such information could be obtained by the upcoming censuses, or perhaps through special local (e.g. township) level assessments.
2. Investment in coastal aquaculture so far is focused on export commodities; and it appears to be mainly wealthier individuals/companies who are directly involved, with shrimp as the main item, and smaller quantities of crab and grouper. Investment by larger companies/individuals has proved important in developing technology and infrastructure for

aquaculture, for example, private sector investment support to shrimp hatcheries and employment, such as several hundred people involved in Myeik (women in soft-shell crab farms) and input supplies (mud crab, trash fish, and grouper fry supply to cage farms in Thanintharyi Division).

3. The opportunities for participation of local smallholders in coastal aquaculture should be further explored, and government, donor and private sector investment could then be focused on support to poor people where opportunities exist. There are major questions of technology, extension support, capital access and security that remain unanswered on the potential for small-scale poverty-focused mariculture. If non-technical constraints can be better understood and addressed, technology for several species might offer opportunities to support small-scale aquaculture in coastal areas, which will contribute to foreign exchange earnings and poverty alleviation through coastal development.

Environmental issues and resource sustainability

4. There are questions about the resource sustainability of aquaculture systems based on capture of wild stocks. Mud crabs, grouper and potentially lobster cultures are based on capture of wild stocks, and sustainable development of such systems depends on sustainable supply of inputs (feed and seed). Value-added culture can provide positive economic benefits to fishers and the country, as they value add to existing resources and provide foreign exchange. However, sustainability is a long-term issue and at least for groupers already appears to be an emerging constraint.
5. Research should be conducted on capture fishery based aquaculture systems to determine the sustainability of present practices and used to prepare advice on sustainable management. Mud crab farming and fattening practices show considerable potential for smallholder involvement and should be given priority in such research because of the high volume captured and traded.
6. Priority should be given to hatchery development for crabs and marine fishes, as a sustainable basis for future development of the industry.
7. Shrimp farming in mangrove environments, classified as 'secondary' mangrove habitats, raises questions of sustainability due to acid sulphate soils, and downstream environmental and social effects due to replacement of mangroves with shrimp ponds, particularly low productivity extensive systems. The role of secondary mangrove systems should be assessed and effective mangrove management plans put in place. Mangroves should be evaluated for their contribution to fisheries, acid-sulphate soil problems, economic values, and retention for mixed silviculture/shrimp farming to diversify income risk among farmers.

Knowledge of sediment dynamics in these coastal regions is also required to identify role of coastal mangroves in sediment entrapment deposition/erosion.

8. The productivity of existing shrimp farming systems developed in mangrove areas is extremely low, in some cases probably less than the fishery values of original mangrove resource (commonly 100-150 kg/ha of fisheries products from other regional countries, but values need to be verified for Myanmar). Upgrading and rehabilitation of low productivity coastal ponds and degraded mangrove areas should continue to be given attention. This may involve introduction of improved aquaculture systems, such as mud crab culture and restoration of mangroves where suitable. Opportunities exist for sharing experience with previous ACIAR/NACA projects on mangrove-aquaculture systems in Viet Nam, and acid-sulphate soil mapping in Indonesia, and SEAFDEC's mangrove research.
9. The Department of Fisheries is making progress in environmental management of more intensive shrimp farms, and is encouraging the private sector through zoning and water treatment protocols. These initiatives are welcome and should be continued and improved for effective environmental management of the sector, and for ensuring sustainability of existing private sector investments. A comprehensive environmental management plan should be agreed with private sector investors in the shrimp industry in Myanmar, as a voluntary Code of Practice for future investment and development of the industry.
10. There is a need to explore and introduce effective coastal planning to support balanced development in coastal areas between aquaculture, coastal fisheries, and other coastal resource uses. The land use policy in coastal areas is directed towards agriculture development, and there appears to be a lack of flexibility in using agriculture land for aquaculture. This may be focusing shrimp farm development towards less suitable mangrove areas, when more suitable aquaculture sites may be available on sub-optimal agriculture land.
11. Coastal planning processes and zoning should be further reviewed with a view to adopting integrated coastal planning processes that would allow for balanced use of resources for aquaculture and other uses. As integrated coastal planning and management is a new concept in Myanmar. One or two pilot areas might be used for testing and development of a suitable approach, for subsequent wider adoption. Zoning principles should be applied to separate major shrimp farming and hatchery zones away from each other, as part of a health management strategy for the shrimp industry.
12. Coral reef resource systems are an important coastal resource for sustaining coastal fisheries, particularly in the southern part of Myanmar. Further information on the status of coral reef resources, people dependant on them, fishing practices and conservation status should

be obtained, as the basis for suitable management measures of this important resource. The DoF has institutional responsibility for one marine protected area in a coral reef area, but has limited capacity and awareness on coral and marine protected area management. It is recommended to build awareness and capacity within DoF for marine protected area management. DoF is also encouraged to explore linkages with the Global Coral Reef Monitoring Network (GCRMN).

Aquaculture technology

13. Most shrimp farms practice traditional methods, but the DoF is trying to encourage improvement of extensive systems, and intensification of shrimp farming in particular is gathering pace with several recent investments in more intensive shrimp farms. The technology and management practices can be further upgraded through capacity building and awareness campaigns based on experiences in other Southeast Asian countries, particularly on issues that influence the sustainability of the sector (e.g. shrimp disease and environmental issues).
14. There are several promising species for diversification of coastal aquaculture in Myanmar, and considerable opportunities to exchange experience with other countries in the region. Technical cooperation with other countries in coastal aquaculture technology and management should continue to be promoted. A programme of technical exchanges should be established, to effectively draw on experiences of other countries, to develop sustainable coastal aquaculture in Myanmar. Such networking should include DoF, the private sector, educational institutes and NGOs (such as the MFF and others active in community development and poverty alleviation).

Institutional support and capacity building

The Department of Fisheries appears to be mainly focused on licensing, and quality assurance through a laboratory in Yangon. A coastal station is planned near Myeik to support mariculture development in an area with significant potential.

15. In general, the mission felt the need to build the capacity for extension and delivery of services to the private sector and coastal poor engaged in aquaculture/fishers. Capacity building among DoF staff, and particularly the younger staff, should be given a high priority. Education and training should be addressed through both short and long-term approaches. A structured approach and plan involving DoF, Universities and NGO's should be prepared for long-term capacity building in the sector.
16. Donor assistance might be provided in designing, developing course materials, training of trainers and teaching, both within the DoF, and in NGOs (e.g. MFF) for better informed management of coastal aquaculture development in Myanmar. Promoting linkages to other countries in the region is essential for effective exchange of experiences and capacity building.

17. The DoF recognizes the potential for future development of mariculture in the southern part of Myanmar. The main initiative for mariculture development in this area within DoF is the plan to establish a marine aquaculture station at Kyun Su Township in Thanintharyi Division, starting in 2003. The DoF plan to start work with seabass culture, but eventually will extend the work to include groupers. External assistance should be considered for training of staff, and design of the facility.
18. Encouraging active participation of NGOs in coastal aquaculture development would be one strategy to build capacity and experience quickly, supplementing the DoF staff limitations.

Aquatic animal disease control and health management

Shrimp disease problems have recently emerged, but are already causing severe economic impacts on shrimp farms in Myanmar, including even extensive farms. The effects on wild populations are unknown, but it appears that shrimp brood stocks are already infected with white spot syndrome virus (WSSV) to varying degrees. There is evidence that WSSV was introduced to the country through shrimp post-larvae. The current situation, if not brought under control through urgent and coordinated action, represents a serious threat to the sustainability of shrimp farm investments, Myanmar's ability to attract foreign investment and future trade status.

19. Policy should be clearly developed on the introduction of species to Myanmar. A national strategy should be formulated and implemented for practical implementation of the Asian Regional Technical Guidelines on Health Management and Responsible Movement of Live Aquatic Animals.
20. The current ban on further imports of live aquatic animals should be continued, including *Penaeus monodon* and *Penaeus vannamei*, since there are no risk assessment measures in place for imports and no facility for quarantine and testing the quality of the imported animals. Introduction of suitable risk assessment procedures, in cooperation with the private sector, is strongly recommended.
21. White spot syndrome virus (WSSV) is proving to be the major current problem in shrimp culture and the mission has identified major risks and actions that can be taken, based on experiences in other countries:
 - a) Establish disease-testing facilities in major brood stock sourcing areas, with priority to Thandwe, to reduce the risks of brood stock contamination being passed to PLs;
 - b) Introduce PCR testing centre in the southern area (for example in Myeik);
 - c) Support PCR testing laboratories by development of standard protocols, training and laboratory procedures. Other countries within the region can

provide assistance in such training and protocol development;

- d) Urgent extension programmes should be undertaken. The government lacks experienced extension staff to support local farmers, and a concerted effort and collaboration between government and private sector should be initiated as a matter of urgency to ensure that farm staff are properly trained, and equipped with the know-how to identify/manage disease problems;
- e) A health management “Code of Practice” should be agreed between government and private sector, including an agreed programme of brood stock testing, chemical and drug use and an agreement on imports of live aquatic animals, that should be a condition of investment in the shrimp farming business in Myanmar; and
- f) Existing experiences from NACA, FAO and ACIAR support in the Asian region should be engaged to support development of a responsible shrimp sector.

The use of chemicals in shrimp aquaculture is a serious concern. The team recommends development of regulations, with the private sector, on chemical and drug use, including a list of banned chemicals, instructions on safe storage/use, ingredients, and withdrawal periods, clearly written in the Myanmar language.

Business investment in coastal aquaculture

There are several large investments on-going or planned for coastal aquaculture in Myanmar. The mission was concerned as to whether the question of (environmental, economic, social) sustainability had been fully addressed, and what the incentives were for long-term perspective on sustainable investment. Problems have already emerged because of introduction of disease by the private sector, which has jeopardized shrimp farm development in Myanmar. The private sector should be encouraged to positively support the development of the sector, such as through longer-term capacity building, and development of Codes of Practice. The mission suggests a Code of Practice be developed with the private sector that would be a condition of further investment in the sector.

Market trends and implications

The current markets for coastal aquaculture products are almost solely export. Products are exported to a wide range of countries, as frozen product (shrimp, soft-shelled crab) or in live form (mud crabs, groupers and lobsters). There are a number of market trends that have implications for coastal aquaculture, particularly shrimp (chemicals, trace-ability, certification), and live marine fish (standards are currently being developed for import of live fish to Hong Kong by APEC). These regional and global trends will influence the future development of aquaculture in Myanmar. The team considers that Myanmar’s coastal environment offers

opportunities for a “clean, green” image for aquaculture products.

There has been some commendable work on quality assurance in Myanmar, and there is a need to continue to develop quality assurance/clean quality product through working closely with responsible private sector. Therefore, the emphasis should be towards responsible development of the sector. This may be accomplished by the development and adoption of Codes of Practice with the private sector that would provide a basis for a set of informal “rules” that might guide investment and management of the export-oriented sector. Myanmar is also encouraged to engage in regional and international discussions on such issues, and promote international investment in aquaculture that adheres to such codes and emerging certification principles.

Coastal fisheries resources

The mission was concerned over the need to generate more updated information on maximum sustainable yields of marine fish stocks, as a basis for sustainable management. IUU fishing, including possible use of destructive fishing practices in coral areas should be further investigated and actions taken to address problem areas. The mission did not investigate this issue in any detail, and are just noting here the need to generate a better understanding of marine fish stocks and catches, to provide a sound basis for sustainable management. Such investigations may be taken up by FAO, UNDP, SEAFDEC and other supporting agencies.

Entry points for support in coastal aquaculture

The mission has identified several initial entry points for collaborative support, with particular reference to the programme areas of NACA, FAO, UNDP and ACIAR programmes. The priority areas include:

- Better understanding of livelihoods of people living in coastal areas, and development of smaller-scale aquaculture farming systems that directly support the livelihoods of poor people. Initial information on coastal livelihoods might come through incorporation of relevant fisheries questions into upcoming censuses and also cooperation with the Asian regional STREAM Initiative.
- Research on the resource sustainability of coastal aquaculture systems, perhaps initially emphasizing mud crabs that represent a significant opportunity for small-scale aquaculture development.
- Development of strategies for environmental sound planning for coastal aquaculture development and integrated coastal area management.
- Research to understand the values of coastal mangrove forests and improving integrated aquaculture-mangrove farming systems.
- Support to development of the mariculture station and programme in southern Myanmar, an area of significant coral reefs and fishery importance.

- Implementation of more effective shrimp health management strategies as a matter of some urgency.
- Support to development of a set of better management practices (BMPs), or a Code of Practice, that can provide the basis for an agreed set of rules for shrimp farm development by the private sector, and ultimately support sustainable development of the shrimp sector, and market access.
- Institutional development through education and training as a long-term initiative to build capacity for responsible management of the coastal aquaculture sector.
- Continued technical exchanges in mariculture development to support diversification and development of mariculture in Myanmar.

Annex 1: Mission itinerary

Coastal team

2nd December

- Team arrives in Yangon

3rd December

- a.m. Meeting with Minister, discussions at DoF.
- p.m. Meeting with UNDP RR and FAO.

4th December

- a.m. Visit to Macrobrachium hatchery.
- p.m. Coastal team visit shrimp farms at Kyauk Tan.

5th December

- Yangon, meetings and discussions with NGOs
- Travel to Thandwe, Rakhine.

6th December

- Thandwe to Taungot, by car.
- Visit shrimp farms in Taungot
- Return to Thandwe

7th December

- Visit shrimp farm and shrimp hatcheries near Thandwe
- Return to Yangon

8th December

- Fly to Myeik
- Discussions with DoF, Visit soft-shell crab farm
- Overnight in Myeik

9th December

- Myeik. Visit to lobster holding, and grouper cage culture.
- Overnight in Myeik

10th December

- Visit fish market
- Return to Yangon

11th December

- Mission meets and works together on report

12th December

- Meeting with DoF and Australian High Commission
- Leave Yangon

Freshwater team

2nd December

- Team arrives in Yangon

3rd December

- a.m. Meeting with Minister, discussions at DoF.
- p.m. Meeting with UNDP RR and FAO.

4th December

- Inland team visit freshwater fisheries station at Hla Ga

5th December

- Mandalay Division Fisheries Office
- 556 acre leasable fishery 10 km south of Mandalay
- Ted They leasable fishery (400 + 350 acres) converted to municipal fish pond, Mandalay

6th December

- Se Dew Gyi reservoir Madaya Township (20 miles North of Mandalay)
- Su Sann Inn, Ta Mak Kone Village Kyaut Sa Yit village tract
- Borrow pit nursery ponds beside road just outside Mandalay
- 75 acre private integrated chicken fish farm, Taung Pyun village 12 km south of Mandalay
- Thaug Tha Man 1 500 acre leasable fishery

7th December

- Peri-urban small-scale hatchery
- Peri-urban small-scale nursing operation
- Mandalay Urban fish market
- Feed mill Mandalay

8th December

- Myanmar Fisheries Federation, Shan State
- 5 acre farm owner, hatchery, nursery, 12 ponds Taung Pakoe Lone Village
- UNDP field office, Nyaung Shwe

9th December

- Inve fisher women, Nyaung Shwe market
- Saung trap fishers, hook and line fishers, trap fishers, Inle Lake

10th December

- Return Yangon

11th December

- Mission meets and works together on report

12th December

- Meeting with DoF and Australian High Commission
- Leave Yangon

Annex 2: A short history of the Myanmar leasable fisheries

This history is summarized from “Fisheries in Burma” by U. Maung Khin, 1948.

The leasable fisheries (Inn leasable fisheries) of Myanmar have a long history and were originally (pre-1864) hereditary properties based upon fixed rents. Under the Burma Fishery Act (1864) the leasable fisheries passed from ownership of individuals into State control. This was considered necessary at the time to be able to effectively administer the leasable fisheries. There were continuing problems with the effective administration of the leasable fisheries and resulted in investigation of fisheries and related problems by Colonel Maxwell in 1895 and culminated in the Burma Fishery Act (III) in 1905 which contained a number of recommendations from the investigation. These covered:

- Conservation of fisheries resources
- Prevention of deterioration of fisheries by siltation
- Modification of the inter-relationships by fisheries lessees and the relationship between government and the lessees.

Conservation

The recommendations of the investigation were the subject of dispute, especially those regarding the creation of ‘reserves’. The reserves were places where fish was prohibited except for predatory fish. These sites were intended as “an annual source of natural stock for replenishing leased fisheries”. The discussion of the time related to the perception that overfishing was not apparent and that revenues from the fisheries was in fact increasing indicating that catches were increasing (although this is misguided as prices were increasing and therefore actual catch may not have been). Similarly increasing consumption was attributed to greater access to the marine fishery catch caused by communications and preservation improvements rather than inland fisheries improvement. There was still no evidence however that inland fisheries catch was actually declining. As a result the ‘reserves’ degenerated into ‘open access’ fisheries, thereby denying the government revenue and in fact the fishing methods were in some cases the same as when they were leased fisheries. There were a range of prohibited fishing methods and certain restrictions that related to migrations of fish.

Prevention of deterioration by siltation

This recommendation related primarily to the avoidance of bunding of rivers and streams in order to prevent siltation of water courses (there was also a suggestion that “weed clearing of stream beds and afforestation of waste lands in the catchment “be organized”).

Modification of relationships

The relationship between lessees in the deltaic areas is problematic when dealing with common stocks and the network of streams and flooded areas and the

recommendation of the study essentially suggested that ‘custom’ should prevail (i.e. conflicts would not be resolved through a legal process but would).

The change from “hereditary property on fixed rents” to the allotting of leases “by favour or by lots at very moderate rent” which occurred in the early days of British rule, had several effects. The income that could be made from the lots led to competition for the leases subsequent problems in the transparency of the allotment process. As a result, the auction system was introduced. This led to a great increase in fishery revenues and ‘gambling bids’ and auction prices increased greatly (around 1900). There was an additional effect of sub-dividing fisheries leases as the administration of the time focused on trying to increase this revenue. To reduce the effect of the auction system and increasing bids, an annual lease was imposed, but the short term nature of the leases meant that lessees had little incentive to reinvest or conserve and encouraged the maximization of the catch.

In 1918, there was an attempt to introduce a system of leasing fisheries to ‘cooperative groups of fishermen’, but this was found to be ‘unworkable’. In 1926 the introduction of ‘fair rents’ was aimed at controlling this process but the establishment of a ‘fair rent’ for such fishery that varied hugely every year in terms of flooding and production also proved unworkable. Whilst the annual lease led to over-exploitation and short-term outlook by the lessees, long term lease also led to lessees making good money in good fishing years and then defaulting on their lease payments during a bad year.

Prior to World War II there were 4 006 Inn Leasable fisheries but post war this had declined to 3 710. By 1948, there was still no settlement of the best system for issuing of leases for leasable fisheries, but a pragmatic policy was in place that prescribed a number of alternative methods:

- Public auction or public sale by diminishing offers
- Inviting tenders
- Extension of existing leases
- (there was also a provision for the Deputy Commissioner to grant leases for ‘fisheries of a fairly constant value’ of up to 5 years)

The conclusion of this is that the management suggestions made by Maxwell were too theoretical and were contrary to the pragmatic system of management that was employed and that further investigation and development of sound legislation coupled to an efficient fishery administration was required.

By 1999 the number of leasable fisheries had further reduced to 3 474 with some of the leasable fisheries sites being converted to agriculture. If the agriculture subsequently failed, the land essentially becomes ‘open fishery’ or available for exploitation by local business interests. This has apparently been the case where the promotion of deepwater

rice cultivation by private sector interests has seen the transformation of substantial areas of leasable fisheries into agricultural land. The subsequent failure of the deepwater rice cultivation locations did not see a return to leasable

fisheries and the current status, ownership and management of these ex-fisheries was not available to the mission although obviously of concern to the DoF due to the impacts on fisheries resources.

Annex 3: List of persons met

Yangon

Brig-Gen Maung Maung Thein	Minister of Livestock and Fisheries, Ministers Office, Yangon
U Than Tun	Director General, Department of Fisheries
U Hla Win	Deputy DG, Department of Fisheries
U Maung Maung Lwin	Assistant Director, DoF
U Thanh Oo Wai	Assistant Director, DoF
U Khin Maung Soe	Deputy Director (Aquaculture Division), DoF Facilitated freshwater team mission throughout
U Minn Thame	Deputy Director (Aquaculture Division), DoF Facilitated coastal team mission throughout
Bhaskar Barua	FAO Representative in Myanmar, FAOR, Yangon
Akiko Suzaki	UNDP Deputy Resident Representative (Programme), UNDP, Yangon
Minako Nakatani	UNDP Programme Manager, UNDP, Yangon
Tin Aung Cho	UNDP Assistant Resident Representative (Programme), UNDP, Yangon
Trevor Wilson	Ambassador, Australian Embassy, Yangon
Roger Walker	Country representative, World Vision, Myanmar
Sow Hia Pawah	Assistant Director, DoF Aquaculture Division Hatchery
U Hoke Sein	Assistant Director, Hlaw Ga Fisheries Station (10 km North of Yangon)
Sann Aung	Central Executive Committee, MFF
Toe Nandar Tin	Central Executive Committee, MFF
U Han Tun	Central Executive Committee, MFF

Mandalay – freshwater mission

U Kyaw Tun	Assistant Director, Fish Farm No. 2 Upper Myanmar, Kume
U Tin Maung Kyi	Deputy Fisheries Officer, Mandalay Division Fisheries Office
U Hla Tin	Assistant Deputy Fisheries Officer
U Tin Myint	556 acre leasable fishery 10 km south of Mandalay
U Tin Myint	Chair of Upper Myanmar Fisheries Federation; Ted They leasable fishery, Mandalay
Irrigation officer and wife	Site Irrigation Officer, Se Dew Gyi reservoir Madaya Township (20 miles North of Mandalay)
U Sein Htun	Owner of land and operator of 120 acres of licenced fish ponds. Su Sann Inn, Ta Mak Kone Village Kyaut Sa Yit village tract
U Htun Yin	Vice chair Upper Myanmar Fisheries Federation .75 acre private integrated chicken-fish farm, Taung Pyun village, Mandalay
U Myint Wai	Thaung Tha Man 1 500 acre leasable fishery
U Win Htay	Peri-urban small-scale hatchery
Daw Htwe Yee	Peri-urban small-scale nursing operation
U Tin Myint	Feed mill Mandalay

Shan State – freshwater mission

U Kyaw Zaw	Myanmar Fisheries Federation
U San Eeye	Chairman MFF (Shan)
U San Yong	Farm owner
U Saw	Farm owner
U Hla Kyaw	Hatchery owner/sugar cane farmer Taung Pakoe Lone Village
Daw Khin Saw Nyant	UNDP field office, Nyaung Shwe
U Soe Win	Translation team
U Aye Lwin	Translation team

Shan State – freshwater mission (continued)

U Nyannt Oo	UNDP Focal Point, Nyaung Shwe
U Myo Nyannt	UNDP Focal Point, Xwangan
Daw Mya Win	UNDP Pinlang
Daw Win Win Shwe	UNDP Pindaya
Hia Myint Hpu	CDW, UNDP, Nyaung Shwe
Inva fisher women	Nyaung Schwe market
Fishers	Saung trap fishers, hook and line fishers, trap fishers. Inle Lake

Rakhine – coastal mission

Myo Aung	District Fisheries Officer Thantwe
U Aye Kyaw	Fishery officer (shrimp)
U Kyaw Nyunt Aung	Farmer
U Muang Maung Soe	Farmer
U San Thuang	Farmer
U Tin Tut	Hatchery manager, Leo Hatchery
U Aung Soe	Technician, Leo Hatchery
U Tun Tun	Technican, Everlive
Daw Than Than Ay	Mya Byin hatchery
Daw Cho Cho Oo	Mya Byin hatchery

Myeik – coastal mission

U Than Oo Wai	Assistant Director
U Soe Win	Chairman, Myanmar Fisheries Market International
U Maung Sitt	Director, Mascot Industries Co., Ltd. (soft shelled crab farm)

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